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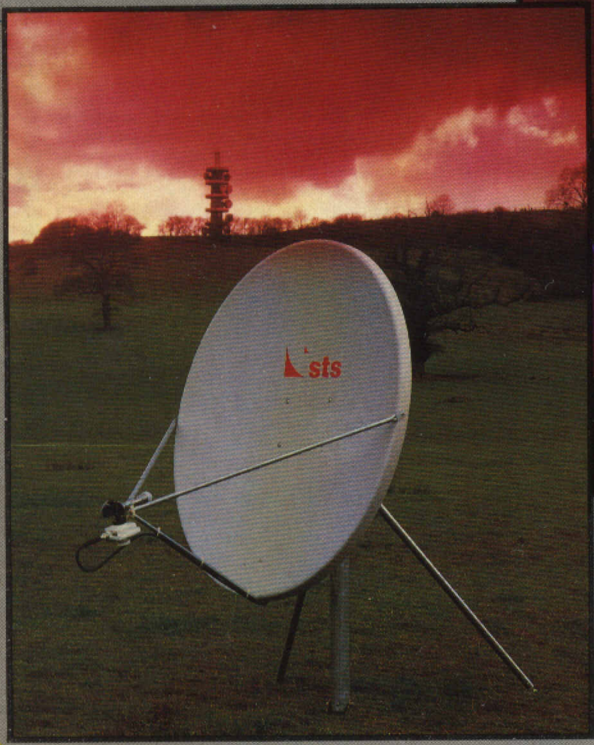
ELECTRONICS

SCIENCE & TECHNOLOGY 45 CHECK SEPT MAG RE THIS ARTICLE

HOBBY BUS PROGRAMMER

PERCUSSION SYNTHESISER

THE ROBOT SKETCH



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From BBC through VCR to DBS

MAINS CONTROL PROJECTS

Two simple projects with many applications

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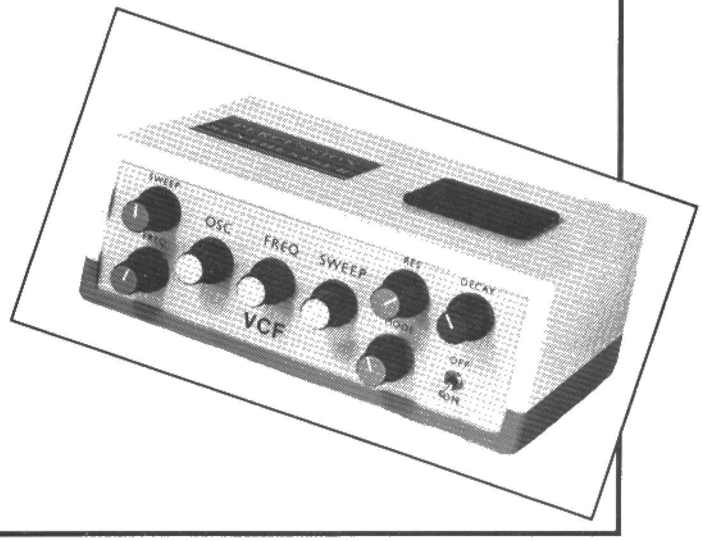
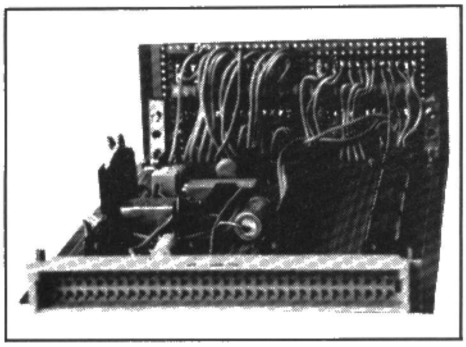
Design ideas in pictures

WIN £400 WORTH OF STE EQUIPMENT

THE SCIENCE MAGAZINE FOR SERIOUS ELECTRONICS AND COMPUTER ENTHUSIASTS

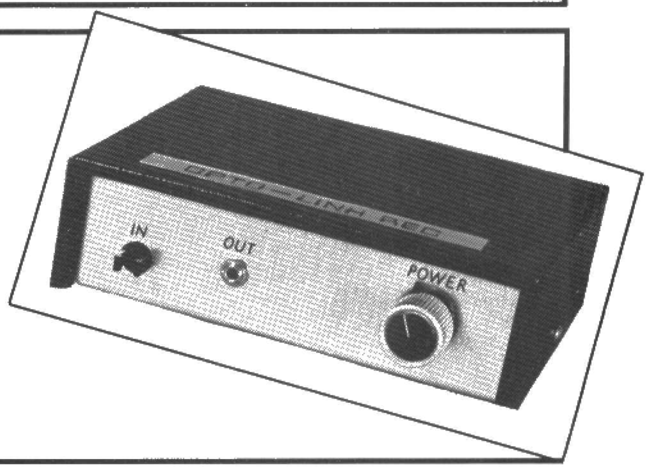
PROJECTS TO BUILD

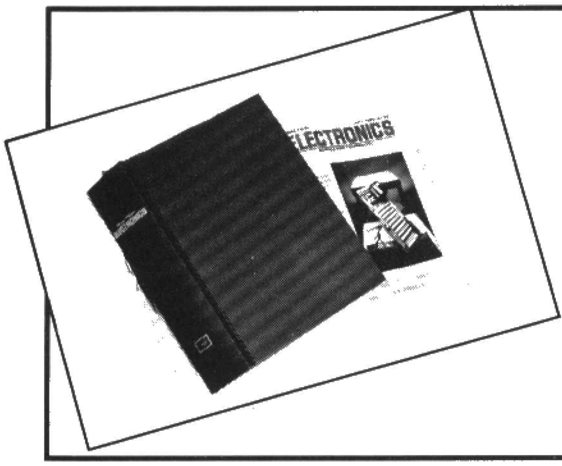




SPECIAL FEATURES

REGULAR FEATURES





NEWS REVIEWS AND VIEWS

THE SCIENCE MAGAZINE FOR SERIOUS ELECTRONICS ENTHUSIASTS

PE SCIENCE AND TECHNOLOGY
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We regret that lengthy technical enquiries cannot be answered over the phone.

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All correspondence relating to advertisements, including classified ads, should be addressed to: **The advertisement manager, Practical Electronics, 25 Glenhurst Avenue, Bexley, Kent DA5 3HQ. Tel. (0322) 521069.**

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In order to avoid disappointments, in the future, we suggest that you take out a subscription. Not only will you avoid missing an issue but you will also save money and in most cases receive your copy before it is in the local newsagents.

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MY BIT AT THE BEGINNING

In my bit at the beginning (August this year) I made a simple statement that "electronics, science and technology are important to us all" and that their promotion and encouragement is vital to the development of individual nations. Whilst I have no doubt as to the long term 'truth' of these views, in the short term, the implementation of new technologies can have disastrous consequences for many.

A recent report published by Policy Studies Institute (PSI) contained good news and bad. The good news is that over half of British factories are using microchips in their products or production processes. The bad news is that over 240,000 jobs have been lost as a result and there is still a massive shortage of suitably skilled personnel.

A solution (or none solution as they aptly put it), discounted in the report as a none starter, would be to slow down on new technology. This, they say, would put us further behind our overseas competitors and lead to even greater job losses. According to PSI, the constructive way forward is to step up training and re-training so as to end damaging skill shortages and to ensure that losses in old jobs are offset by gains in new ones.

All well and good, but its an old solution offering the same false hopes. The truth is that unemployment will never be eradicated. Granted, new technology will pave the way for an economically brighter future for individual nations, including Britain, but near-full employment can never result. Indeed, the purpose of new technology is to make advancements with as little human labour input as possible.

I believe that the only positive way forward is to combine training and retraining in new technologies with training and retraining in new, possibly radical, social attitudes. Why promise jobs for the long term future? What consolation is that to today's casualties of the microchip revolution, even if the promises are fulfilled?

Richard Barron

DID YOU KNOW?

Over 80% of our readers own one or more personal computers.

From our survey, it seems that the most popular articles in PE deal with: computer interfacing, home computers and microprocessors. Test instruments and logic based projects are close second.

Over 60% of our readers are involved in the electronics industry or education.

OUR NOVEMBER 1986 ISSUE WILL BE ON SALE FRIDAY, OCTOBER 3rd, 1986 **(*see page 57*)**

WHAT'S NEW . . .

POINTS ARISING

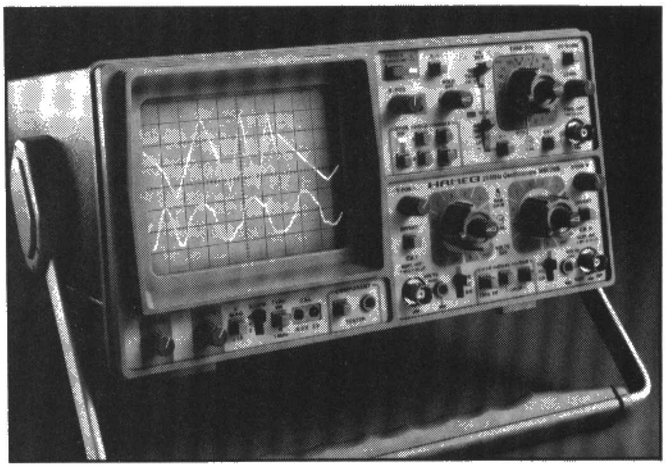
STEbus ADVANCED SINGLE BOARD COMPUTER

We have had several letters expressing concern at the publication of our SBC which we claimed was STE compatible. Whilst congratulating us on our choice of system, many of our readers pointed out several reasons why the design is not STE. For these reasons we will not be publishing any constructional details for this project but to stimulate further interest in the processor used in the original design we have published some software ideas this month.

Also we would like to express our thanks to Bob Squirell, chairman of the STE Manufacturers and Users Group for his support and help in our attempt to bring you an industrial standard bus system. We have now commissioned several STE designs which, for those interested, will be published in forthcoming issues of PE. We apologise to those readers who may have been inconvenienced by these problems.

APOLOGY

Practical Electronics would like to apologise to Mr Selby-Lowndes for publishing his letter in our August issue. The letter was intended to be 'Private and Confidential'.

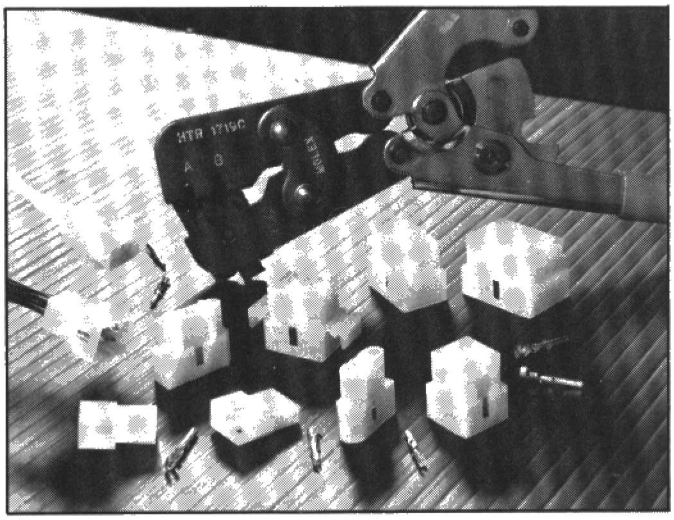


Cheap Storage

Hameg Limited have launched the world's lowest cost dual channel digital storage oscilloscope the HM205. Priced at £448.00 plus VAT (including probes).

In addition to providing the impressive features of a well-designed 20MHz real-time oscilloscope, the new HM205 permits storage and display of slow-occurring signals and events (from 50sec to 0.1msec).

With a maximum sampling rate of 100KHz, the resolution of 1024 x 256 points for the X- and Y- axes is great enough to register and display even the most minute waveform details. In the "Refresh" mode, waveform, amplitude and frequency changes are visible immediately. Signals recorded in the "Single-Shot" mode can be stored until the instrument is switched off, even if the instrument is operated in any of its real-time modes. With an optional add-on, the memory contents can be retrieved as hard copy using a chart or X-Y recorder. In many applications, when slow phenomena below 10KHz are involved, the HM205 can perform the functions of much more expensive digital storage scopes.



Connector System

The 1625 series connectors now offered by Nortronic comprise a range of rectangular plugs and mating receptacles in UL 94V-2 rated nylon. Different modules in the range can house from one to 24 contacts. Available with or without mounting ears, which allow the housings to be panel-mounted, these connectors are both UL and CSA approved. All housings accept both male or female Molex 0.062in. (1.58mm) crimp terminals.

Maximum voltage rating is 600V a.c. while maximum current rating depends on the number of contacts: 1 to 15 contacts (5A), 24 contacts (4A). Contacts for these connectors accept wire sizes from 18 to 30 a.w.g., and contact material is 70/30 stock tin-plated. Crimping handtools, both ratchet and plier types, are also stocked. Nortronic now stocks a full range of these connectors together with matching contacts, and crimping tools.

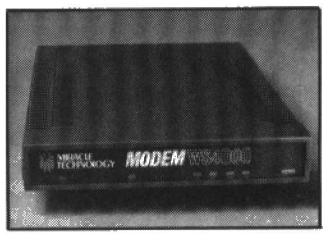
Hayes Modem

Miracle Technology (UK) Ltd., a leading modem manufacturer, has launched a new low-cost intelligent modem called the WS4000.

Fully intelligent and speed buffered, the WS4000 offers autodial and autoanswer as well as Hayes-type compatibility for only £149.95 exc.

A major feature of the WS4000 is its upgradeability. In its standard version the WS4000 supports the CCITT V21 and V23 standards, offering speeds of 300, 600, 1200, 1200/75 and 75/1200 baud. A host of optional upgrades includes V22 1200 baud full duplex and V22bis 2400 baud full duplex, plus options of DTMF tone dialling, battery-backed internal telephone directory, process control port, and fully approved BELL standards for transatlantic communication. All options are available at the time of original purchase or as later factory upgrades.

The WS4000 modem has been approved for connection to the British Telecom public telephone network and is already in full production at Miracle Technology's new factory in Ipswich.



Inmos Change

Please note that the new INMOS Bristol address is: INMOS Ltd., 1000 Aztec West, Almondsbury, Bristol.

New Breadboard

A new solderless circuit development/prototyping board is now available which enables both schematic theoretical circuits to be built and tested and p.c.b. layouts to be designed. The suppliers, Camboard, claim that this is the only solderless board to do this. Camboards are available with several options which allow 0,1,3 or 6 i.c. holders to be inserted anywhere on the board. Batteries for powerlines are connected via stud/sleeves where up to ten 1mm wires can be pushed in.

The boards measure up to 180mm x 129mm x 129mm and have alphanumeric grids for easy reference. Electrical connections are made from solid metal studs. Prices range from £4.25 to £7.95.

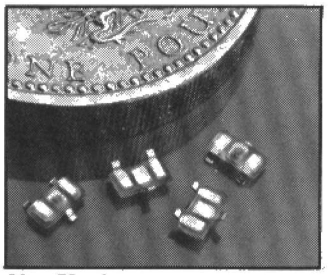
WHAT'S NEW . . .

SM l.c.d.. Range

Further additions to the Taiwan Liton LTL 907 range of LEDs for surface mounting applications have been announced by Selectronic of Witney.

The devices, which are packaged in Sot-23 outlines, measure approximately 3 x 1.5 x 1mm, excluding mounting contacts, and both offer a typical viewing angle of 140°.

The LTL 907NK device has a 'super-bright' GaA1As chip which illuminates as high intensity red and the LTL 907JK device is fabricated from an orange GaAsP on GaP chip. Both devices are of dual dice construction.



New Versions

SGS Systems Division have introduced two new versions of their GS-R400 series of power regulators; both are stocked by Unitel.

A smaller package houses the new GS-R400/2 series of lower-power switched-mode regulators, whereas the existing GS-R400 has been redesigned to give better heat sink efficiency.

These high-efficiency switching regulator modules require only 4V drive overhead, which combined with their integral heatsink means that no further heatsinking is required in many applications. The high switching frequency of 100KHz imparts efficiencies in excess of 75% even with an 8V overhead.

Milestone 100

Disassemblers/debuggers for more than 100 different microprocessors are announced today by Thorn EMI Instruments Limited for its new Universal Development Laboratory (UDL).

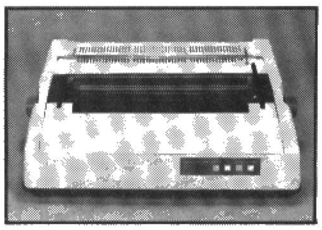
The Z8001-Z8004 series from Zilog, Intel's 8096 and 8097, Motorola's 68HC11 and the HD64180 from Hitachi are some of the microprocessors which can now be interrogated by the UDL.

The UDL combines a 48 channel Bus State Analyser, 8/16 Bit Universal Emulator, EPROM/EEPROM programmer and input stimulus generator – and sets new standards in the cost effective integration of debugging functions for microprocessor-based systems hardware and software.

The UDL converts almost any personal computer, operating MS-DOS or CP/M, into a microprocessor development workstation offering huge time savings. Its symptom-based diagnostic routines 'side-step' conventional debugging techniques.

Daisy-Cheap

C-Itoh Electronics Ltd has introduced a new low-priced DaisyWheel printer offering full Diablo 630 compatibility. The D10-40 offers 136 columns and provides maximum 40 character per second (CPS) performance at a low noise level of under 60dB. The new printer's design has been based on a redesign of C-Itoh Electronic's popular F-10 40 to offer lower price, yet retaining the F10 40's outstanding performance and reliability. It retails at about £750.



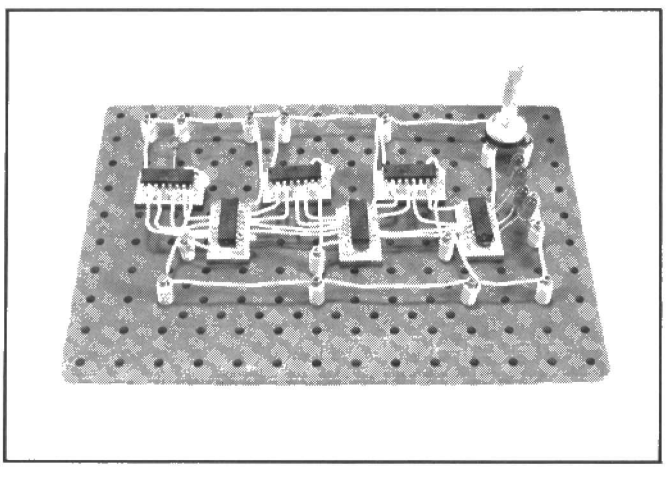
War Batteries

Crompton Vidor, the industrial and defence batteries subsidiary of Crompton Parkinson Limited, a Hawker Siddeley company, has introduced the RT03/40 lithium 'reserve' battery. Designed for military applications, the new battery is capable of delivering full power on demand after inert storage for more than 20 years.

The very long-term 'reserve' storage characteristics of the battery are derived from its special internal construction. The battery electrolyte is sealed in a glass ampoule inside the cell, ensuring total isolation from the active electrodes and rendering the battery completely inert. It is activated by breaking the glass by mechanical, electrical or explosive impulse as required, releasing the liquid electrolyte and enabling the electro-chemical reaction to take place.

The new battery uses established lithium-thionyl chloride technology and has a nominal voltage of 3.65 volts on activation with a capacity of 280 mAh. The battery is nominally rated at a current of 0.5mA but is capable of delivering a high rate pulsed output up to hundreds of milliamps. Each single-cell battery is just 12.8mm diameter and 21.3mm in height.

Typical applications for the Crompton Vidor RT03/40 lithium battery include scatterable anti-armour and anti-personnel mines, grenades, decoys, time and impact fuses and rocket fuses. There are more peaceful applications as well!



CATALOGUE CASE BOOK

During the last month we have received the following catalogues, information sheets and bulletins:

A new shortform catalogue from Powerline Electronics listing details of their **power supplies.** Postage paid cards also included. Details from: Powerline Electronics Ltd., 5 Nimrod Way, Elgar Road, Reading RG2 0EB. Tel: (0734) 868567.

Colour brochure on new **A/D co-processor** board for **Multibus Systems.** Details from: Datel, Belgrave House, Basing View, Basingstoke, Hants. Tel: (0256) 469085.

Cirkit Education Division **electronic component and equipment** catalogue. Details from: Cirkit Education Division, Cirkit Holdings PLC, Park Lane, Broxbourne, Herts. Tel: (0992) 444111.

Prices and product description brochure from Rastra Electronics (**electronic components**). Details from: Rastra Electronics Ltd., 275–281 King Street, Hammersmith, London W6 9NF. Tel: 01-748 3143.

THE LEADING EDGE

Developments in digital TV have led to the world's first digital video recorder – at a price of $100,000. It looks as if it will be some time before the technology is available to the consumer. That is even if he wants it.

DIGITAL video is on the way. Sony was taking orders for the world's first digital video recorder at the 64th NAB in Dallas earlier this year – that's the annual convention and international exposition of the National Association of Broadcasters, to give it the full title. Until now digital video has been an experimental technology. The UK broadcasting and studio industry will get a chance to see the Sony recorder at the International Broadcasting Convention to be held in Brighton this autumn.

The Sony recorder will be ready for delivery next April and will cost over $100,000. So it certainly isn't a consumer toy. There are no plans yet to produce a domestic version. The technology is daunting and there is probably no need for a domestic digital video recorder. The advantage of recording video signals as digital pulses instead of analogue waves is that there is virtually no loss of picture quality, even when the recording is copied over and over again, through several 'generations'. This is routine practice in professional work, where tapes must be edited by dubbing and special effects added. When an analogue video signal is copied it degrades a little at every generation; the waveform distorts and becomes blemished with random noise and interference. As long as a digital system can distinguish between one and zero pulses it works as well with poor recordings as good ones. Domestic users seldom need to copy tapes. They may copy once for editing home video movies or making up compilations, but as long as the copying is done at video level (ie not with rf signals) there is no appreciable loss of quality.

WORLD STANDARD – D1

The Sony system conforms with a recently agreed world standard called D1. A cassette of 19mm tape stores a TV signal as digital code instead of an analogue waveform. There have been several demonstrations of digital video over the past five years, but they have all relied on experimentally modified analogue recorders which were not for sale. D1 is tailored to digital technology. Although the D1 tape is the same width as U-Matic cassette tape, as used for industrial and some broadcast video, it is quite different. D1 tape has a metal powder coating of much higher coercivity. The D1 cassette is deliberately not of the same design as U-Matic to avoid confusion.

D1 is a world standard because a D1 cassette recorded anywhere in the world will play back on any other D1 system. Although there are three different cassette sizes, to offer anything between 10 and 90 minutes recording time, the recorder automatically adjusts its drive mechanism to match whichever cassette is loaded. The digital coding standard has been carefully chosen to make the system work equally well with 525 line pictures (as broadcast in the US and Japan) and 625 line pictures (as used in Europe).

HOW?

This is done by starting with three raw analogue 'component' signals; a luminance or black and white signal and two chrominance or colour signals. Normally, for broadcast or analogue recording, these components are mixed together to make a 'composite' signal of whatever the local TV standard may be, for example PAL for most of West Europe, several varieties of SECAM for France, the Middle East and Eastern bloc countries and NTSC for the US and Japan. For D1 digital recording the raw components are converted into digital code, without ever being composed into PAL, SECAM or NTSC.

The analogue luminance signal is chopped up or sampled at 13.5 MHz and both the chrominance components are sampled at 6.75 MHz. This system is called 4:2:2 component coding because of the mathematical ratio between the sampling rates for the component signals. It is equivalent to breaking down each line of the TV picture into 720 picture points or pixels. The human eye does not notice that there is less colour detail as long as the black and white signal is precisely coded.

The obvious advantage is that component coding cuts across the artificial boundaries created by NTSC, PAL and SECAM. The penalty is the large amount of data which must be stored on tape. Each sample is described in 8 bit code. When extra error correction bits have been added to

protect the signal against tape blemishes, the result is a data stream of 216 million digital bits a second. This is 50 times the data rate needed for compact disc digital audio.

The signals are recorded, as in a conventional analogue video machine, by heads on a rapidly rotating drum which obliquely scans the tape. But there are four heads on the drum instead of the usual two, so twice as many information tracks are recorded across the tape.

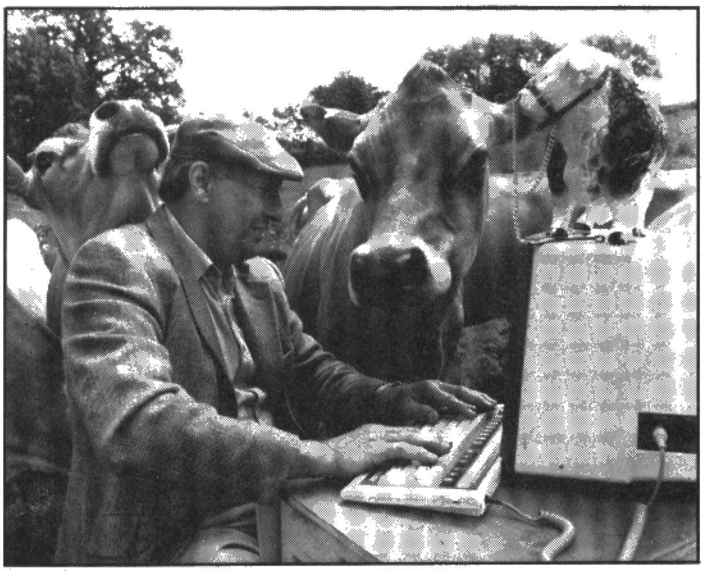
MADE TO BE BROKEN

Standards it seems are made to be broken. A US company, Ampex, which unveiled the world's first analogue video recorder at a NAB convention in Chicago exactly 30 years ago, has upset the standards organisations (particularly the European Broadcasting Union) by proposing that the D1 cassette should also be used for composite coding. The TV signal is sampled and coded after composing it for broadcast in NTSC, PAL or SECAM. This places less demand on the recorder, because only one composite signal instead of three components, need be digitised. But it rebuilds the national TV standard barriers which the broadcast industry had hoped to break down with 4:2:2 component coding.

Engineers are watching with interest to see whether Ampex demonstrates the composite digital system at Brighton.

BY BARRY FOX

WHAT'S HAPPENING . . .



COUNTDOWN

If you are organising any electrical, computing, electronic, radio or scientific event, big or small, drop us a line. We shall be glad to include it here. Address details to Countdown, Practical Electronics, 16 Garway Road, London W2 4NH.

NOTE: some exhibitions detailed here are trade only. Please check details and dates before setting out, as we cannot guarantee the accuracy of the information presented here.

Custom Electronics & Design Techniques, Sept 4–6, Heathrow Penta. (A)
Milan Fair. Sept 4–8. Milan. (Trade only)
International Video and Consumer Electronics Show, Sept 4–8, Milan. (B)
Farnborough International 1986, Sept 5–7, Farnborough. (C)
Microelectronics Repair & Maintenance, Sept 9, London, one day seminar. (D)
IBC 86, Sept 19–23, Brighton. (E)
British Laboratory Week, Sept 23–25, Olympia. (A)
ITAME, Sept 23–25. (A)
Sound Comm '86, Oct 1–2, Manchester. (F)
Test and Transducer, Oct 28–30, Wembley Conference Centre. (G)
Audio '86, Nov 12–15, Olympia 2.
Drives/Motors/Controls & PC Systems, Nov 25–27, NEC, Birmingham. (A)
Instrumentation '87, Feb 25/26, Harrogate Exhibition Centre, March 25/26, Bristol, Crest Hotel.

(A) Evan Steadman. ☎ 0799 26699.
(B) Segreteria Generale: 20149 Milano. ☎ 02/4815541.
(C) Society of British Aerospace Companies Ltd. ☎ 01-839 3231.
(D) SERT. ☎ 01-388 3071.
(E) IBC. ☎ (0932) 47785.
(F) ASCE, ☎ (06286) 67633.
(G) Trident International Exhibitions Ltd. ☎ (0822) 4671.

Church flys the flag of Cellnet

In order to preserve the environment, they say, BT has erected four aerials on top of a church in Cheshire. They have disguised them as flagpoles. It's no coincidence that it's one of the highest points in the area. No jokes about trying to get a quick answer to your prayers.

BT have also added another service to Prestel – Farmlink, arranged in conjunction with the Milk Marketing Board. One of the services provided by Farmlink is a dating service for cows and bulls. Farmers are able to locate the best stud for their herd through the Bullpower pages which are full of prize bull statistics. It's for Moo-Hoo.

Cash for Corporation

Hawker Siddely, the international electrical and mechanical engineering group has agreed to buy Daytronic Corporation, of a privately owned USA corporation, for £15 million cash.

Car Audio in China

Philips have teamed up with Gold Peak, of Hong Kong, to produce audio systems for the car industry. Production is expected to start by the end of the year with Philips supplying the marketing know-how and Gold Peak jointly supplying the industrial know-how.

FACTS from Hitachi

Fairchild's FACT family of semiconductors, described in our August issue, were launched in October last year. Hitachi are now second sourcing these products. They will be manufactured using similar technology to that of the originals.

Both Fairchld and Hitachi will be continuing development of FACT devices and more devices should be available soon. At the moment only about 40 devices are available.

Free Software

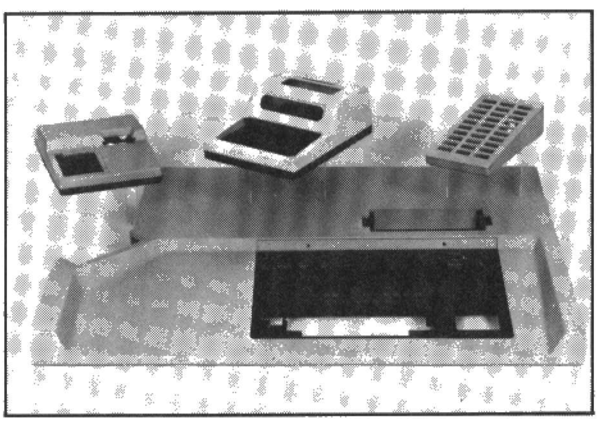
A large range of software is available free of charge if you have a modem. Mektronic Consultants has about 6Mbytes of software available which includes over 100 programs such as games, operating system expansions, text processors and electronic disks.

The software can be accessed directly from Mektronics computers by calling their computer line by modem: Computer Line. 061-773 7739. 300/300 or 1200/75 Baud teletype standard 8-bit data, no parity (press CR to set Baud rate).

The system is on-line 24 hours per day and can be accessed by various machines including IBM, BBC and Amstrads. It is available under the public domain concept – if you find it useful, you are invited to make a contribution to the author.

Precision Plastic Process

It is now possible to manufacture precision moulded plastic housings without the high tooling cost and long lead times of injection moulding. The novel Surface Forming Process (SFP) developed by TTV of Germany, which is now available through Mi-Net Technology Ltd, is able to produce mouldings with sharp edges, fine detail, textured surfaces and all the other advantages normally associated with injection moulding.



This is achieved with tooling costs around 10–20% of the injection moulding equivalent and an average lead time of 8 weeks between design approval and prototype delivery, this making SFP the ideal solution for the small to medium scale manufacturer who requires a high quality housing, but who is put off by the high tooling cost of injection moulding.

WHAT'S TO COME . . .

Tec Jobs

By the end of the year, at least 500 jobs will have been created by Hi-Tech giant Brother as a direct result of demand for their new electronic typewriters manufactured at the company's recently opened £ multi million plant in Wrexham – the first British-based typewriter factory for over ten years.

The plant's 240,000 targeted output figure for the end of 1986 was initially expected to create 150 direct jobs. But with burgeoning orders for the company's typewriters – which range from electronic portables for the domestic market to the most sophisticated office machines – Brother will shortly attain its full daily capacity of 950 units, requiring a local workforce of around 250 people. In fact, the new typewriters are proving so popular that a further expansion of production capacity by 30% is expected in the near future to meet the increasing demand.

Increased productivity at the company's European manufacturing base will not only create new jobs in the Wrexham area but will also improve job opportunities across the UK at all of Brother's component suppliers.

On the face of it, this seems to disprove this months 'bit at the beginning' but this is not the case. It is quite likely that many more jobs have gone forever in the mechanical typewriter industry. Never-the-less, good luck Brother.

Cinderella Syndrome

To the modern social observer, Cinderella's success might well be regarded as having been essentially a matter of luck overcoming decidedly unequal opportunity. There might also be concern, on health and safety grounds, that the Fairy Godmother supplied a potentially dangerous product – namely one pair of glass slippers. Had she had the right manufacturing technology at her fingertips – rather than a flash of inspiration – maybe the outcome would have been quite different.

In reality, however, the age of equal opportunity and modern technology is already with us, and luck is regarded as little more than a useful bonus. Today worthwhile opportunities for professional careers in the electrical and electronic engineering field are just as relevant to women as to men.

This realisation sets the scene for the 1986 Girl Technician Engineer of the Year Award, nominations for which must be received by no later than 3rd October 1986. The Award itself will be presented at a ceremony in London during December by HRH The Duke of Gloucester.

For further details and copies of the 1986 Award nomination form, please apply to: The Secretary, IEEIE, Savoy Hill House, Savoy Hill, London WC2R 0BS (Tel: 01-836 3357).

Wireless Fees to Rise

The DTI have decided to increase the cost of most licence charges covered by the Wireless Telegraphy regulations. Amateur and citizen band radio licences will remain the same and TV licences are not covered by these regulations.

Sensor Opportunities

Opportunities in the rapidly growing field of sensor technology – miniaturized integrated sensors – will be assessed by a team of researchers at Battelle in a new multiclient study.

State of the art as well as conventional manufacturing techniques will be evaluated with the objective of helping decision-makers select the most suitable and cost-effective method to their own needs.

In addition to technical information, the study will provide data on current markets, trends, applications, and manufacturing economics. Results of the study will benefit manufacturers of sensors, electronic systems and components, automotive and machine manufacturers, as well as users of sensors in such applications as measurement and instrumentation, heating, cooling, air conditioning, household appliances, and many other industrial uses.

Social Automation?

Under a government contract announced today, British Telecom is to provide equipment and services to allow the Department of Health and Social Security's 500 local social security offices and its central offices at Newcastle-upon-Tyne and North Fylde, to access the various benefit systems being developed under the department's Operational Strategy.

This will permit the streamlining of DHSS service to claimants.

RS Go To The Public

RS Components, the long established trade supplier of electronic components and related equipment have recently launched a new service – Electromail. Electromail is a mail order service available to the general public.

This is welcome news for PE readers as many of our projects have included items only available from RS. Second sourcing has always been difficult.

A 688 page catalogue is now available from Electromail which covers the complete RS range of over 13,000 products.

For a copy, send £2.50 inc p&p to: Electromail, PO Box 33, Corby, Northants NN1 79EL or use your Barclay/Access card by telephoning 0536 204555.

FIRM CONTACT

Details of products, services and companies mentioned in News and Market Place can be obtained from the following sources:

Camboard, Unit 9, Robert Davies Court, Nuffield Road, Cambridge CB4 1TP. Tel: (0223) 329470.

Crompton Parkinson Ltd., Woodlands House, The Avenue, Cliftonville, Northants. Tel: (0604) 30201.

Unitel Ltd., Unitel House, Fisher Green Road, Stevenage, Herts SG1 2PT. Tel: (0438) 312393.

Nortronic Associates Ltd., Gateway, Crewe Gates Industrial Estate, Crewe CW1 1YY. Tel: (0270) 586161.

C. Itoh Electronics, Beacon House, 26–28 Worple Road, Wimbledon, London SW19 4EE.

Hitachi Electronic Components (UK) Ltd., 21 Upton Road, Watford, Herts DW1 7TB. Tel: (0923) 46488.

Thorn EMI Instruments Ltd., Archcliffe Road, Dover, Kent CR17 9EN. Tel: (0304) 202620.

Avel-Lindberg Ltd, South Ockendon, Essex RM15 5TD. Tel: (0708) 853444.

Hameg Ltd., 74–78 Collingdon Street, Luton, Beds LU1 1RX. Tel: (0582), 413174.

Cherry Electrical Ltd., Coldharbour Lane, Harpenden, Herts. Tel: (05287) 63100.

Powerline Electronics Ltd., 5 Nimrod Way, Elgar Road, Reading RG2 0EB. Tel: (0734) 868567.

Selectronic Ltd., The Old Stables, 46 Market Square, Witney, Oxon OX8 6AL. Tel: (0993) 73888.

Miracle Technology (UK) Ltd., St. Peter's Street, Ipswich, IP1 1XB. Tel: (0473) 216141.

IEEIE, Savoy Hill House, Savoy Hill, London WC2R 0BS. Tel: 01-836 3357.

Mi-Net Technology Ltd., 30 Summerleaze Road, Maidenhead, Berks SL6 8EN. Tel: (0628) 783576.

Brother Typewriter Division, Jones and Brother, Shepley Street, Guide Bridge, Audenshaw, Manchester M34 5JD. Tel: 061-330 6531.

DTI, 1 Victoria Street, London SW1H 0ET.

Micronet 800, Telemap Ltd., 8 Herbal Hill, London EC1R 5EJ. Tel: 01-278 3143.

PERCUSSION SYNTHESISER

BY R.A. PENFOLD

A project easily beaten!

A noise based percussion synthesiser with a variety of dynamic and useful effects, especially if used in conjunction with the modulated syndrum unit described last year

PERCUSSION synthesisers fall into two main categories, tone and noise based types. The former produce conventional drum sounds, as well as disco type falling pitch sounds. A few offer more complex sounds, such as the "Modulated Syndrum" which was described in the October 1985 issue of Practical Electronics. This design enables various types of frequency modulation to be used in addition to simple sweeping in sympathy with the envelope generator. The design featured in this article is a noise based percussion synthesiser, and it is designed to complement the Modulated Syndrum unit. It can produce the usual hand clap, cymbal, and wave type sounds, but many other sounds can be generated by modulating the filter. It is difficult to describe the sounds as they have no real natural equivalents, but the modulation facilities are sufficient to provide a wide range of dynamic and useful effects.

The unit can be triggered by tapping a pad on top of the case, either by hand or using a drumstick, and when activated in this way it is touch sensitive. It can also be triggered by a brief trigger pulse at normal logic levels it desired, but the touch sensitivity is lost if this method is used. The output level is a few volts peak to peak from a low impedance source, and the unit should drive any mixer, amplifier, or other normal piece of equipment without any difficulty.

SYSTEM OPERATION

Although they are essentially quite simple, the modulation facilities provided by the unit are potentially a little confusing, and the block diagram of Fig.1 helps to explain the way in which they operate. It is advisable for anyone who intends to use the unit to study Fig.1 and the following explanation, even if they are not particularly interested in the way in which the unit operates, as it would be difficult to make really effective use of the unit without having

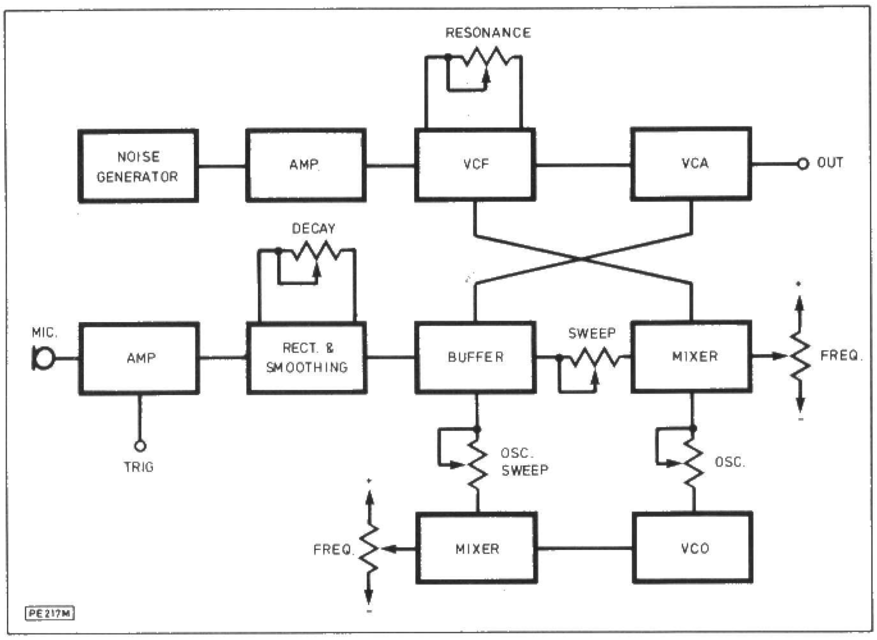
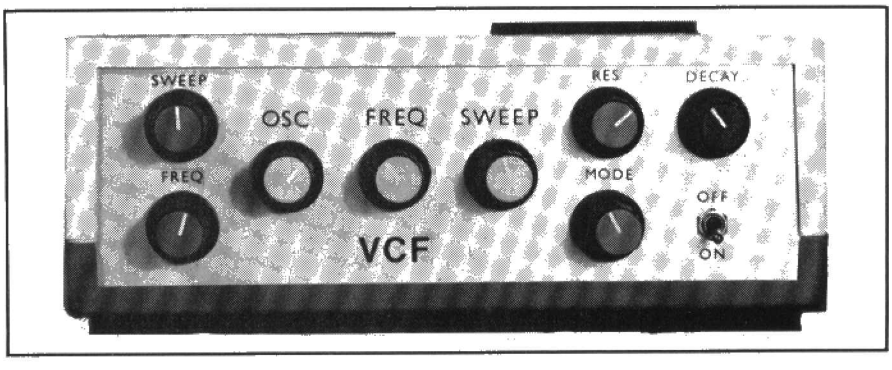


Fig.1. *System block diagram*

at least a basic understanding of the function of each control.

A noise generator produces the basic white noise "hissing" sound, and as the noise generator produces only a low level output an amplifier stage is used to boost the signal to a more satisfactory level. The amplified signal is fed to a voltage controlled filter (VCF) which can provide lowpass, bandpass, and notch filtering. It has a resonance control which can be advanced to give a very peaky bandpass response or a peak in the lowpass response just below the cutoff frequency. The sounds associated with a swept or modulated VCF set for a high degree of resonance should be familiar to anyone who has used a conventional analogue synthesiser. The resonance control is less useful when used with notch filtering, as it makes the notch very narrow and renders the filtering almost totally ineffective.



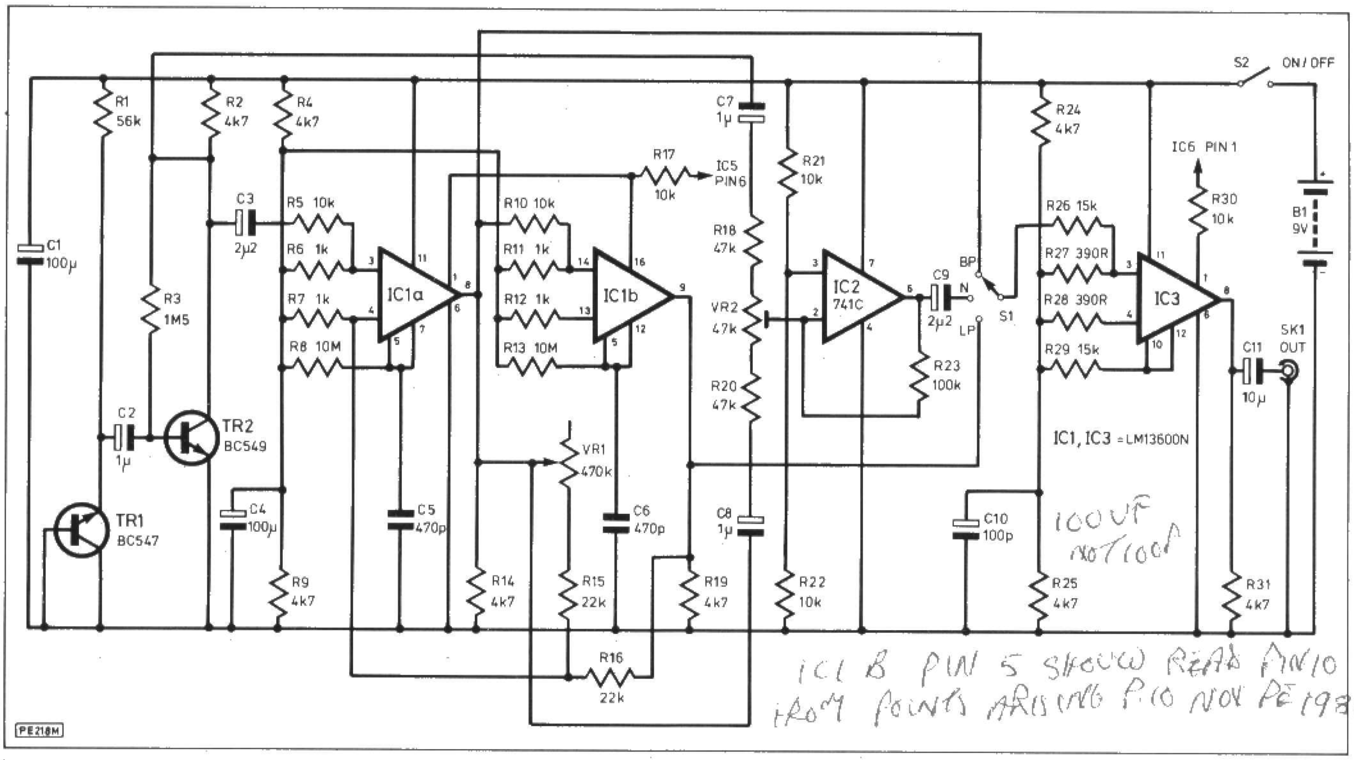


Fig.2. *Signal generator and processing stages*

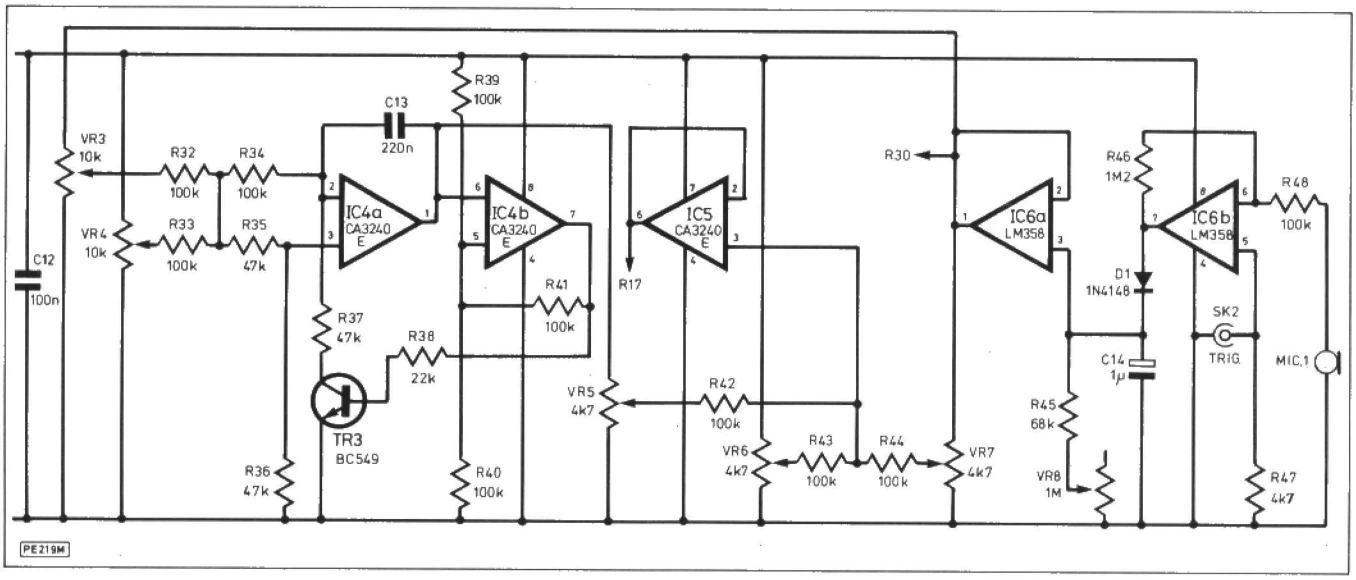


Fig.3. *VCO and control voltage generator*

The filtered signal is fed to the output via a voltage controlled amplifier (VCA) which forms part of the envelope generator. When triggered manually a built-in microphone picks up the vibrations produced when the unit is struck, and these are then amplified before being fed to a rectifier and smoothing circuit. This circuit has a fast attack but relatively slow decay time, and it produces a ramp output voltage from the burst of input pulses. This ramp signal is used to drive the VCA, but as the output signal is at a high impedance a buffer stage is needed to match it to the relatively low input resistance at the control input of the VCA.

The envelope generator is, of course, just a simple attack/decay type rather than the more complex and versatile ADSR (attack –decay – sustain – release) type. However, for percussion effects an attack/decay type is perfectly satisfactory. The attack time is fixed at just a few milliseconds, but the decay time can be varied from around 100ms to a maximum of about 2 to 3 seconds. This enables anything from short clap type sounds to long cymbal type sounds to be generated.

Operation of the unit is much the same when a trigger pulse from a computer or other sequencing device is used, with the signal being fed to the amplifier and from there to the rectifier and smoothing circuit etc.

There are three control voltage sources for the VCF, and a mixer is used to combine the three sources in the required relative quantities. One source is just a potentiometeer fed from the supply rails, and this acts as a manual tuning control. The second source is the envelope generator, and this can provide falling pitch effects. Finally, a voltage controlled oscillator (VCO) having a roughly triangular output waveform can be used to provide cyclic sweeping of the VCF.

Using a VCO as one of the modulation sources enables further modulation

possibilities. The control input of the VCO is fed from a mixer which is in turn fed from two signal sources. Again, one of these is a potentiometer fed from the supply rails so as to provide a manual frequency control. The second source is the envelope generator, and the effect of using this is to set the VCO at a high initial frequency which then drops away as the control voltage decays. This can provide some very interesting effects, especially when it is used in conjunction with some of the envelope signal being fed to the VCF. Of course, the VCO is a low frequency oscillator, and when set at its maximum frequency it is still in the sub-audio range at only about 10Hz or so. The circuit diagram for the signal generation and processing stages appears in Fig.2, while the circuit of the VCO and envelope generator appears in Fig.3.

Taking Fig.2 first, the noise signal is generated by TR1 which is a silicon npn transistor with its base – emitter junction reverse biased. This causes it to avalanche like a zener diode, and also in common with a zener diode it generates noise spikes. Compared to a zener the bandwidth of the output signal is much more restricted, but the output is a good quality audio white noise signal, and the output level is far greater than that provided by most zener diodes. It is still only a few millivolts peak to peak though, and a high gain common emitter amplifier based on TR2 brings the signal up to a more suitable level.

IC1 is a dual transconductance operational amplifier, and it is connected as a standard state variable filter with a bandpass output at pin 8 and a lowpass output at pin 9. Each amplifier has a built-in Darlington pair emitter follower at its output so that a low output impedance is achieved in both cases. The operating frequency of filter is determined by the current fed to the amplifier bias inputs of the two amplifiers, but R17 is added ahead of these inputs so that the bias current is roughly proportional to the input voltage. This effectively converts the filter from current to voltage control. VR1 is the resonance or Q control, and when this is set at minimun resistance the filter operates normally. Advancing VR1 results in the Q value of the filter increasing, and a narrow peaky response being produced.

IC2 is a simple mixer stage which mixes the unprocessed noise signal with the output from the bandpass filter. Although one might not expect this to have much effect on the frequency response with the bandpass type being retained, due to phase shifts through the filter there is a strong cancelling rather than additive mixing effect and the notch in the frequency response is produced. VR2 is adjusted to give a notch of maximum attenuation with the resonance control set at minimum. Advancing the resonance control tends to narrow the notch and produce a peak in the response, and the notch filtering is most effective when used with minimum resonance. Mode switch S1 enables the required type of filtering to be selected. By feeding C8 from the lowpass rather than the bandpass output of the VCF it is possible to obtain a highpass response. This does not seem to produce particularly good effects though, and so no highpass option has

COMPONENTS . . .

RESISTORS

R1	56k
R2, R4, R9, R14, R19, R24, R25, R47	4k7 (8 off)
R3	1M5
R5, R10, R17, R21, R22, R30, R31	10k (7 off)
R6, R7, R11, R12	1k (4 off)
R8, R13	10M (2 off)
R15, R16, R38	22k (3 off)
R18, R20, R35, R36, R37	47k (5 off)
R23, R32, R33, R34, R39, R40, R41, R42, R43, R44, R48	100k (11 off)
R26, R29	15k (2 off)
R27, R28	390 (2 off)
R45	68k
R46	1M2

All 1/4W 5% carbon film

POTENTIOMETERS

VR1	470k lin
VR2	47k min hor preset
VR3, VR4	10k lin (2 off)
VR5–VR7	4k7 lin (3 off)
VR8	1M lin

CAPACITORS

C1, C4, C10	100μ 10V radial elect (3 off)
C2, C7, C8, C14	1μ 63V radial elect (4 off)
C3, C9	2μ 63V radial elect (2 off)
C5, C6	470p ceramic plate (2 off)
C11	10μ 25V radial elect
C12	100n ceramic
C13	220n polyester layer

SEMICONDUCTORS

IC1, IC3	LM13600N or LM13700N (2 off)
IC2	741C
IC4	CA3240E
IC5	CA3140E
IC6	LM358
TR1	BC547 (see text)
TR2, TR3	BC549 (2 off)
D1	1N4148

MISCELLANEOUS

SK1, SK2 3.5mm jack sockets (2 off); S1 3 way 4 pole rotary; S2 SPST miniature toggle; B1 9 volt (PP3 size); Mic.1 Ceramic resonator; Case about 205x140x75mm; printed circuit board available from PE p.c.b. service, order code PE121; small control knob (8 off); Battery connector; 16-pin socket (2 off); 8-pin socket (4 off); wire, pins, solder, etc.

been included in the filter switching.

The VCA is based on another transconductance amplifier, and it is an entirely conventional circuit. Note that the second amplifier in IC3 is not required in this application, and that no connections are made to it.

Turning to Fig.3 now, the VCO is built around IC4. The circuit is a variation on the familiar Schmitt Trigger/ Miller Integrator configuration with IC4a acting as the integrator and IC4b as the trigger. This gives a squarewave output from IC4b and a triangular type from IC4a. For modulation purposes a triangular waveform with its relatively low harmonic content provides good results, and it is only this waveform that can be fed through to the VCF.

Normally this type of oscillator is not voltage controlled, and the conversion to voltage control is obtained by modifying the trigger stage to include switching transistor TR3, and adding input resistors R34, R35, etc. This gives excellent results, and the VCO achieves excellent linearity without the turn-on threshold voltage of about 0.6 volts that afflicts many simple VCO designs. However, the circuit will only operate with a single supply rail if the operational amplifier is a type which can operate with both its inputs and its output at potentials right down to the 0 volt supply rail. As high impedances are also involved it is preferable to use a fet input type, and the CA3240E has ideal characteristics for this application. Other types are unlikely to work properly in this circuit.

The mixer at the input of the VCO is a simple passive type using R32 and R33, with VR3 controlling the sweep level and VR4 acting as the frequency control.

The mixer circuit which combines the envelope, VCO, and frequency control bias voltages is a another simple passive type which uses R42 to R44. The amount contributed by each voltage source is controlled by VR5 to VR7. IC5 simply acts as a buffer to match the high output impedance of the mixer to the fairly low input resistance of the VCF. The use of passive mixers in the unit has the advantage of extreme simplicity, but it has the disadvantage of a strong level of interaction between one control and another. However, in practice it is still quite easy to set up the controls for the desired effect.

Mic1 is the pick-up in the envelope generator, and this can be either a ceramic resonator or a crystal microphone insert. IC6b is the amplifier stage, and for the microphone signal it operates in the inverting mode with a voltage gain of about 12 times. As far as the trigger signal is concerned, IC6b operates in the non-inverting mode. IC6 is operated without a negative supply rail, and it therefore rectifies the input signal. D1 is therefore not needed for rectification purposes, but to prevent smoothing capacitor C14 from discharging into the output stage of IC6, but it can discharge through the relatively high resistance of R45 and VR8, giving a long and adjustable decay time. The low output impedance of IC6b ensures that the attack time is suitably short. IC6a is the buffer amplifier which gives the envelope generator a low output impedance. Note that the LM358 used for IC6 is another type which can operate with its inputs and outputs at potentials right down to the 0 volt supply potential, and that this is an essential characteristic for correct operation in this circuit.

The current consumption fo the unit is about 14 milliamps. This can be provided by a PP3 size battery, but if the

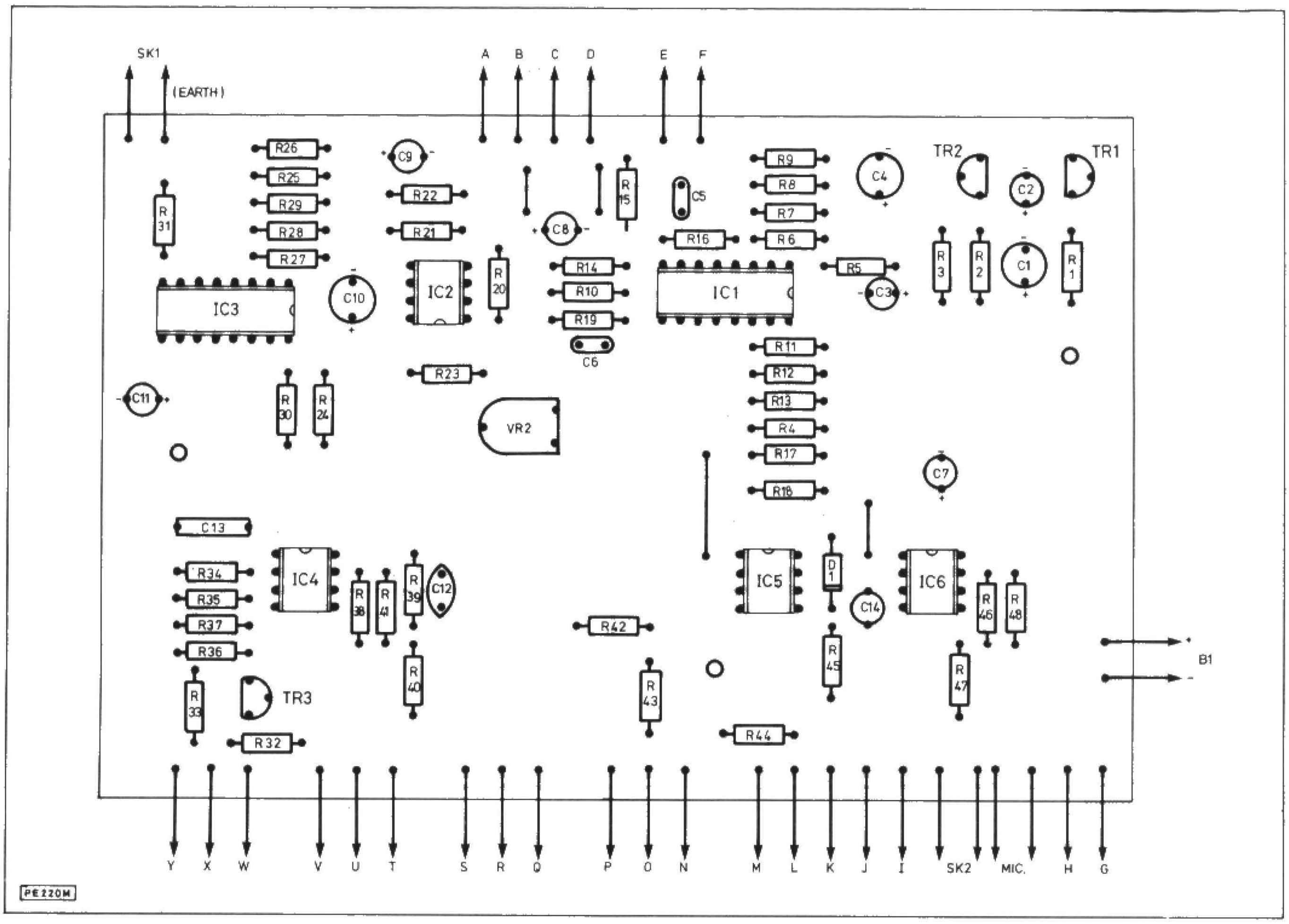


Fig.4. *P.c.b. and component position details*

unit is likely to receive a great deal of use a higher capacity type such as six HP7 size in a plastic holder would be preferable.

CONSTRUCTION

The small components all fit onto a single printed circuit board, as shown in Fig.4 IC4 and IC5 both have MOS input stages, and consequently they both require the normal antistatic handling precautions. IC1 and IC3 are not very cheap types, and it is probably worthwhile fitting these in sockets as well. Some component retailers now supply the LM13700N instead of the LM13600N, and either type is perfectly suitable for use in the IC1 and IC3 positions of this circuit.

There is nothing unusual about construction of the board, but take care over the normal stumbling blocks such as getting th ICs fitted with the correct orientation, and not omitting any of the link wires (there are four of them). Pins are fitted at the numerous points where connections to off-board components will be made.

Tr1 can be virtually any silicon npn transistor, but some devices work better than others. The important factor is a low base – emitter reverse breakdown voltage, and with some devices this voltage might be too high to permit correct operation, or the circuit might only function with a new or nearly new battery fitted. Several BC547s were tried, and only one failed to work well in the circuit. Probably most constructors will be able to find a suitable device in their spares box.

A plastic case with metal front and rear panels and dimensions of about 205 by 140 by 75 millimetres is used as the housing for the prototype. This is a good match for the modulated syndrum which has the lower profile version. Similar cases are unsuitable for this design as the large number of controls necessitates the use of a case having a fairly large front panel area if the controls are not to be unduly crowded. In fact a reasonable expanse of front panel is needed if the controls are all to be accommodated at all. The layout used on the prototype can be seen from the photographs, and in order to make the wiring up as straightforward as possible it is advisable not to radically alter this layout. The two sockets are mounted on the rear panel, but it would probably be possible to squeeze them onto the front panel if desired.

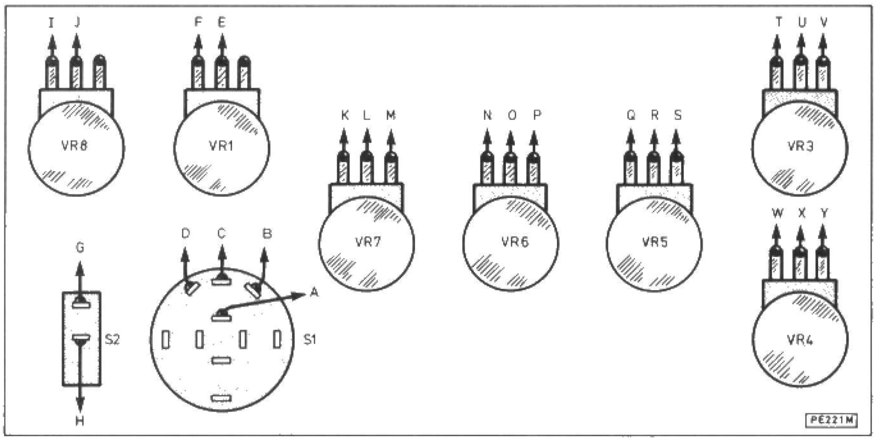
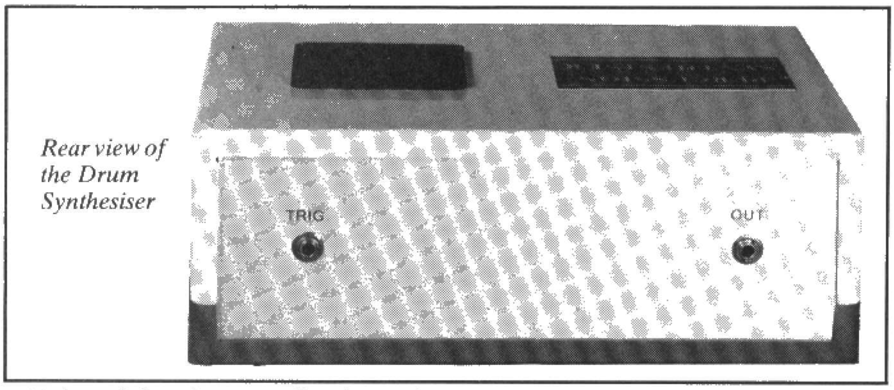


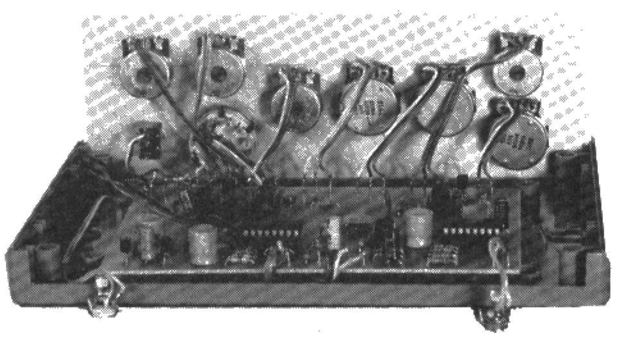
Fig.5. *Further wiring details*

Details of the wiring to the controls is shown in Fig.5 in conjunction with Fig.4 (e.g. point "A" in Fig.5 connects to point "A" in Fig.4). Ordinary multi-strand connecting wire can be used here, but the wiring will be neater and easier if pieces of ribbon cable are used.



Rear view of the Drum Synthesiser

If the unit is to be manually triggered it is a good idea to fit a pad of foam material on the top panel of the case where the unit will be struck. Apart from protecting the case, this will also help to minimise any mechanical noise from the case when it is struck. In the interests of low mechanical noise it is also advisable to use a case having a plastic outer casing and not a metal case. The pick-up can be glued to the case at any convenient point, and it does not have to be immediately under the pad on the top panel. In fact this would probably give excessive pick-up, and it is better to mount it on the base panel. If the pick-up is an uncased ceramic resonator, two leads must be soldered direct to the body of the component. One connects to the inner (silver) area while the other is connceted to the (gold coloured) outer ring. Both connections must be made with the soldering iron being applied to the joints for no longer than is absolutely necessary so that heat damage is avoided.



Internal construction details of the Drum Synthesiser

ADJUSTMENT AND USE

When first trying out the unit it is probably best to have the VCF oscillator and sweep levels both set at zero. By repeatedly triggering the unit the VCF frequency, resonance, and mode controls can be checked, as can the decay time control. These are the only controls that most noise based percussion synthesisers provide, and even with just these a useful range of sounds can be obtained. For example, with minimum decay time, high resonance, bandpass filtering, and a fairly high VCF frequency, hand clap sounds can be obtained. Using a little less resonance and a longer decay time gives cymbal type sounds.

The trigger input is well suited to CMOS signal levels, but LSTTL outputs also seem to work perfectly well with the unit. It is important that the trigger pulses are of suitable duration, and anything from about 2 to 20ms should suffice. PE

INDUSTRY NOTEBOOK

The fate of the British Chip Industry hangs in the balance as Inmos makes further rationalisations. Plus May Day and the Big Bang – they need electronics.

Despite uncertainty about its future as a company, Inmos, the UK chip maker, continues to develop new VLSI products and put them on the market. The latest is a signal processing chip containing 32 high-speed multipliers and other functions which can be programmed to form a digital filter. Lots of them can be cascaded and the possible applications are in control engineering, radar, sonar and speech and image processing.

Meanwhile the original Transputer has been built up into a whole family of products. This now includes 32-bit and 16-bit Transputers, a disk processor, four communication links, various evaluation boards and a range of associated software tools. Inmos claims to be selling these throughout Europe, Japan and the USA, though the costs of doing this in the middle of a semiconductor recession must be considerable.

There are doubts about Inmos's future because its present owners, Thorn-EMI, find themselves in possession of a firm which has been making a loss every year except one since its formation. You'll perhaps recall that Thorn-EMI took it over in late 1984 by buying the British Technology Group's majority shareholding in the company. BTG is a government agency carrying the responsibilities of the old National Enterprise Board which had started Inmos as a state-owned VLSI manufacturing company in 1978.

The latest financial results from Inmos, for the 15-month period to the end of March 1986, show sales of £63 million but a trading loss of £33 million. To reduce costs the company has pulled out of the highly competitive dynamic RAM business, selling off its manufacturing technology to a Japanese firm, and has made 220 people redundant in the UK (see the "Bit At The Beginning"). In addition Inmos has run down its production plant at Colorado Springs, USA, at a cost of £59 million and a loss of 450 jobs there but resulting in a saving of about £23 million a year.

For the future, Inmos is abandoning its original high-volume VLSI manufacturing policy and concentrating on high-value VLSI products instead. These are devices which like the Transputer are complex, specialised and costly to produce.

They sell at correspondingly high prices but probably in small quantities. If the company succeeds in this new market strategy and manages to at least break even, Thorn-EMI will no doubt keep it going. Otherwise Inmos may be sold off again – if there are any willing buyers still around – or just closed down. Let's hope an upturn in the semiconductor market will come to the rescue.

ELECTRONIC FINANCE

May Day and Big Bang are the colourful names of two events in the world of financial services that are closely tied up with electronics.

On 1st May 1975 in the USA, dealing in securities was de-regulated. In other words the fixed commissions earned by firms dealing in stocks and shares were abolished. Commissions had to be negotiated. As a result profit margins were drastically reduced and many firms went to the wall. Those surviving were the big dealers with plenty of capital behind them who could exist on extremely small margins by taking on huge volumes of business.

Information technology was moving into US financial services anyway, but May Day gave this process a new urgency. The big dealers had to use the fastest and most efficient methods of transmitting, processing and displaying financial information in order to survive on their tiny margins. Now, for example, two stock markets in the USA are completely electronic. These are the Cincinatti Stock Exchange and the National Association of Securities Dealers (the third largest in the world after New York and Tokyo).

Similar developments are taking place in the UK. Indeed the City of London is in an utter frenzy of activity leading up to Big Bang on 27th October. This is the day when, as far as the pin-stripe brigade is concerned, a new universe is being created.

In Britain stock market deregulation means two things. Not only are fixed commissions being abolished but the traditional demarcation between jobbers (who don't deal with the public) and brokers (who do) is being swept away. As a result new conglomerates are being formed which combine the functions of jobbing, broking and banking all in one company. Most of the banks concerned are British but additional capital is coming in through American, European and Japanese banks taking part.

Again, information technology started to appear in UK financial services a good many years ago. Dealers' desks had sprouted display screens and keyboards, news agencies like Reuters and Exchange Telegraph had started providing electronic financial information services and the Stock Exchange had installed central electronic systems for distributing price information and automating transactions for its members. For Big Bang all these systems are now being modified or expanded, while the new conglomerates are installing completely new electronic dealing rooms.

The UK electronics industry is involved in three ways. First, of course, the shares of the big public companies will be bought and sold under the new regime. Secondly, small electronics firms at present on the Unlisted Securities Market may find difficulty in raising capital through this channel because the new financial conglomerates may not find it worthwhile dealing in their shares. Thirdly, some electronics companies are making a lot of money out of the new information and transaction system. One securities firm alone, Barclays de Zoete Wood, is spending some £20 million on the electronic equipment for 600 dealing desks.

But May Day and Big Bang are really only two local, contributory events in the long-term internationalisation of markets for capital. PE

BY NEXUS

TV - THE COMPLETE PICTURE

BY BARRY FOX

From mechanical TV to DBS

Several recent reports have indicated that people of all ages are spending more and more of their leisure time watching the box. It is probably true to say that TV has affected our lives, directly or indirectly, far more than any other single technological development. This article takes us from J.L. Bairds Invention through video recording and cable TV, to satellite reception.

FIFTY years ago this November, the BBC began broadcasting all-electronic television from Alexandra Palace. At the time it was called a "high definition" service. This was to distinguish it from the mainly mechanical systems developed by John Logie Baird in the late 20s and broadcast up until the thirties.

HISTORY

In May, 1934 the Postmaster General and government had set up a committee headed by Lord Selsdon. Its brief was to advise on the technology to be used by the BBC for TV broadcasting. Selsdon's choice narrowed to an improved Baird system, with 240 line resolution, and an all-electronic 405 line system developed by a team of Marconi-EMI engineers under Isaac Shoenberg. The team included electronics genius Alan Blumlein. Partly for political reasons, the committee did not decide which system should be used.

When the committee reported in January 1934 it said the BBC should try using both systems. In September 1935 the BBC shut down its TV service using Baird's 30 line system. After 18 months of feverish work by both teams of engineers, Britain's "high definition" TV service began with the same programmes transmitted in two different systems, on alternate days and then alternate weeks. Engineers likened working with the Baird system to playing with clockwork. In February 1937, the inevitable happened. The Baird system was dropped. Britain forged ahead with all-electronic television.

It is written in industry folklore that the British Government saw the introduction of an advanced TV service and the growth of an industry to make cameras, transmitters and receivers, as a way of generating a sound manufacturing base for radar equipment. There is some evidence that this folklore is based on fact. Certainly radar and TV technology are inextricably linked. Blumlein died while testing wartime radar. More facts may emerge as once-secret documents are released.

The BBC TV service shut down, on 1 September 1939, because it was feared the transmitters might serve as a homing beacon for Germans bombers. In fact they were used to broadcast radio signals intended to confuse the enemy's airborne navigation systems. The BBC began transmitting TV programmes again in June 1946. The technology used was exactly the same as that adopted before the war, a 405 line interlaced picture broadcast on the VHF wavebands. This has since proved a controversial decision.

HANKEY (without pankey)

With commendable foresight the British Government set up another committee during the war, under Lord Hankey, to advise on the future of British television. The Hankey Committe was appointed in September 1943 and reported in 1945. It recommended that a British TV service should start again as soon as possible after the war to keep the country's lead in technology. *To leave a gap of some years without any television service would damp interest and seriously retard commercial development of the television industry in this country"* advised the Committee. But it also recognised that the 405-line system needed improving. So Hankey also recommended that "vigorous research work with the aim of producing a radically improved system of television should begin immediately staff can be made available" adding that "television definition should eventually be of the order of 1000 lines and the introduction of colour and stereoscopic effects should be considered".

Although work on 1000 line TV was done by EMI in the late 40s, nothing ever came of it. It is the Japanese who are now leading the world in HDTV; today's High Definition TeleVision has 1125 lines and is in widescreen colour format, instead of 3D.

The French experimented with 819 line TV, but all Europe agreed in the sixties to upgrade with a 625-line picture format; the first BBC2 programmes on 625 lines were transmitted from Crystal Palace in April 1964. Britain was first in Europe with colour in 1967 choosing the West German PAL (Phase Alternation Line) system in preference to the American NTSC approach which Japan also adopted. Officially NTSC stands for National Television System Committee. Engineers prefer the words "never twice the same colour". The PAL system compensates for the changes of colour which are caused by phase shifts in the broadcast NTSC signal.

LE DIFFERENCE

Different as always, the French chose SECAM (SEquential Couleur A Memoire). This protected France against cheaper imports from the Far East – but it slowed technical development and made it well nigh impossible for the French electronics industry to export. Protectionism is a two-edged sword.

The 625-line transmissions in Britain are all on the UHF band. At these high frequencies, signals travel in almost straight lines. So the coverage area of each transmitter is smaller than for a VHF transmitter. Although there are technical arguments in favour of either VHF of UHF cover, Britain had no choice in the matter. To keep faith with viewers using 405-line standard on the VHF wavebands when it introduced the 625 line services. This tied up the VHF bands until the service shut down at the end of 1984.

The UK Government on advice from a committee chaired by Dr. James

Merriman, decided not to make the released VHF frequencies (in Bands I and III) available for entertainment radio or television broadcasting. Instead Bands I and III have been allocated to land mobile radio. This should ease congestion and stimulate both new and existing industry.

There is no room in the UHF bands for any more TV, and a wider choice of programming. This is where satellite, cable and video enter the picture.

VIDEO RECORDING

In the 60s, electronics companies round the world were striving to produce a gramophone record which could store colour TV pictures and sound. They saw vidoedisc as a way of providing entertainment, quite literally on a platter. Dozens of systems were developed, of which four came to the market in one form or another. The Telefunken-Decca TeldecTeD disc was grooved and tracked at high speed by a superfine stylus; it ran for 10 minutes only and died commercially almost as quickly. Philips' Laservision is an optical disc, without groove and tracked by a laser; it has proved the most sucessful system. RCA's CED was a grooved disc with capacitance changes sensed by a conductive stylus; it came and went. JVC's VHD is a grooveless disc which also works on the capacitance principle. It has never really arrived, (except in Japan).

All systems, except Teldec's disc, met the original design goal, enough capacity to store a full feature film on a single disc. Unfortunately none was ready to sell early enough to succeed on the domestic market. By the time videodisc was a saleable commodity, video tape was already there for the buying. The electronics industry found it impossible to sell a videodisc, which plays back but does not record, in competition with a video tape, which both records and plays back.

Videodisc still struggles on as a domestic system in some countries. VHD is sold in Japan and laservision in Japan, the US and UK. The real feature for the technology is as an interactive tool. The fast access time available from video discs makes it the ideal medium for carrying picture sequences which are displayed under computer control and merged with text and graphics sourced from the computer. Laservision technology has of course also spawned the hugely successful compact disc digital audio system.

Video tape was originally conceived as a time shift medium; a way of taping a television programme one day to watch the next – or the next month or next year. Effectively video tape gave TV viewers and extra channel to choose from. For many years the video industry tried to sell video tape as a direct competitor to videodisc. They offered feature films for outright sale. But the price was too high. The public just would not pay £40, £50 or £60 for a film (and that was several years ago when money bought more). The breakthrough came with rental. The public jumped at the chance of hiring a film for the night or weekend for a few pounds. A whole industry has grown out of tape rental. It has effectively created another channel of TV entertainment. This is why disc has failed on the domestic market.

In the cold light of consideration, both tape and disc are clumsy and inelegant ways of distributing programmes. The customer travels to a shop, chooses a package, takes it home and must then make another trip to the same shop to return it. Of course many people enjoy shopping, but all the arguments in favour of cable and satellite are that in the long run the public will opt for the armchair approach. Cable television and satellite television are ways of delivering extra channels of entertainment into the home, without making any extra call on the limited bandwidth available for conventional broadcasting. At one and the same time, cable and satellite both compete and cooperate. The balance is fine and not yet understood, let alone set.

CABLE

Cable distribution is not a new idea. Parts of Britain were cabled as early as 1925. There was often no mains and radios relied on re-chargeable lead-acid accumulators. The first cable stations offered 55 volt radio signals which could direct-drive a loudspeaker. The signals were distributed at 500 volts, by two kilowatt amplifiers, and stepped down by transformers to safe level for the home. At one time, around the end of World War II, nearly one in two British radio licence holders was wired up in this way.

By 1950 the Home Office had licensed three companies, EMI, Rediffusion and British Relay, to distribute 405 line TV signals on the radio cables. For cable relay the VHF broadcasts were dropped in frequency to the HF band, at 8.9MHz. Repeaters were needed every 1500 metres to compensate for signal loss at even these frequencies. The old systems relayed at 30 volts, on a twisted pair of copper wires, one pair per TV channel. The same technique has been used to relay 625-line pictures in colour, but it is stretching the technology to breaking point. In 1975 around 2.5 million homes received TV by cable. This peak figure remained level until 1980 and has been falling off since then to below 0.5 million now. Many of these homes receive their TV signals by cable out of necessity; either because off-air reception is impractical (the area may be in a valley) or local authorities (like Milton Keynes) will not allow residents to erect roof aerials. The majority of these homes still rely on twisted wire pairs. The rest are served by more modern copper coax.

Coax gives the wide bandwidth needed where the cable station relays more than just the broadcast programmes which are available off-air in the area. The station may for instance offer out-of-area channels picked up by a very tall mast aerial, or a community channel generated locally, or special programmes like feature film at a premium price.

Almost half the homes in America are served by 10,000 cable Systems. This is because off-air reception is poor – the buildings are tall and coverage areas vast. The broadcast programmes are mostly terrible, and ruined by commercial breaks. It makes good sense to pay for a cable conncetion, *and* pay extra for premium programming.

But the cable has more to offer than wall-to-wall pap. In June 1981 Prime Minister Margaret Thatcher appointed a panel to advise her and the Government on information technology. In March 1982 this Information Technology Advisory Panel published its first report on cable. ITAP recommended that Britain should be cabled in time for a new direct Broadcasting Satellite service then scheduled to start in 1986. ITAP also recommended that star switching be used.

In a switched star system very wide bandwidth trunk lines, of optical fibre, carry a large number of programme signals simultaneously down the same cable. On each street corner a switch bow converts the optical signals into electrical signals for routing to subscribers' homes by conventional copper coaxial cable. The coaxial cable has narrower bandwidth than fibre but it need only carry a few TV channels at the same time. No one watches more than a few programmes at once. So each subscriber choses which programme channels he/she wants at any given time. Control signals generated by a keypad in the subscriber's home trigger the street corner switches so that one or two selected channels are sent to each home. Different homes can all have different – or the same – channels.

BRANCHING OUT

The technology used in virtually every existing cable system is traditional tree and branch. The main trunk line carries all the programmes on offer. Branch lines carry off all of the programmes on offer to individual homes. Electronic circuits block those which the subscriber is not entitled to see.

Obviously tree and branch distribution is wasteful on bandwidth, because at any one time most of the signals running down a cable are not being used. So the total number of signals has to be limited. Also it is difficult to send signals back up the cable link from the viewer's home to the cable station. And back-channels are

the key to interactive technology. They open the door to voluntary surviellance, for instance, baby, burglar and fire alarms which send TV pictures out of the home, back up the cable and into a central control station. The snag is that laying a two way star system is more expensive than a simple one way tree and branch.

The Home Secretary appointed Lord Hunt to produce a report on cable. Hunt was not concerned with technology, only programming. Throughout 1982 the British Government, led by Kenneth Baker (then Information Technology Minister), kept reminding people how valuable it would be to have a wired Britain with a wide bandwidth, interactive system. *"Broad band cable means much more than an increase in the number of TV channels" said Baker.*

In December 1982 Kenneth Baker announced that the licence period granted to firms interested in cabling Britain would depend on the technology used. They would get a 12 year licence for tree and branch and 20 years for switched star. A fortnight later the Home Secretary William Whitelaw contradicted Baker and said that all franchises would start at 12 years. The Department of Industry set up a working group under Dr. Tony Eden to produce drafts for technical standards. In November 1982 Sir Anthony Part published his report on DBS and reminded Britain that *"DBS needs cable for reception and cable needs DBS for choice of programming"*. In April 1983 the Home Office published a White Paper on cable and promised that 12 pilot systems would be licensed each covering 100,000 homes. The Home Office said that British Telecom and their private sector rival, Mercury, could offer even telephone services down cable links. It looked as if Britain was up for rewiring.

But the plans collapsed. In July 1983 the Dapartment of Trade and Industry invited applications for twelve cable TV franchises. There were 37 applications. With confidence the DTI said only 11 were good enough to get a licence. The lucky 11 were told that they had to lay their cables underground, in ducts, to make replacement easier in years to come. The tax man threw a spanner in the works, by arguing that ducting did not qualify for a capital allowance tax relief. The 1984 Budget started to phase out capital tax relief, anyway. The tax man relented on ducting, but not on capital relief. Kenneth Baker left the DTI to dissolve the GLC. His successor Geoffrey Pattie seems to know little and care less about IT. The Home Office created a Cable Authority which seems to be having little success in wiring Britain. "Low key" would be a polite way of describing its image. The overall impression now is that if anyone with surplus millions is seriously interested in investing in cable they are welcome to a once-prized licence.

Thorn-EMI started to lay new tree and branch cables in Swindon, at a cost of £300 per house. The only station laying switched-star is Westminster Cable in London. The heavy cost, around £500 a home, is subsidised by British Telecom. Why? Because BT developed switched-star technology and wants a shop window for future sales, to both UK and foreign firms.

SKY CHANNEL AND MUSIC BOX

Sky Channel (mixed programming) and Music Box (pop videos etc) are transmitted from Eutelsat 1–F1. But Sky is scrambled and decoders are only available to hotels, blocks of flats and other SMATV (Satellite Master Antenna TV) systems. Children's channel, Cable News Network, Premiere film and Screen Sport, come from Intelsat V. If you want Russian programmes, they come from another satellite called Gorizont. There are also French and German stations available on Eutelsat and Intelsat, if you speak the language.

Galaxy is a company which gives out licences for people to watch Premiere, Children's Channel and Screen Sport. It costs around £10 per month per household. You pay a couple of pounds more for Music Box. It's cheap, because it's on a different satellite.

You will need two dishes, or one dish on a steerable mount to receive from both satellites. The Russian satellite is at a different position again, and on a different frequency. It's not worth the bother.

The dish aerial must be between one and two metres in diameter to pick up watchable signals. The larger the dish, the better the signal. Dish and electronics to feed signals into the aerial socket of an ordinary TV set, will cost between £1000 and £2000. The difference shows up on rainy days, when a large dish and better electronics still pull in pictures. Delivery and installation will usually be extra. Check prices carefully, so that like compares with like.

The trade dreams of a £500 system, but it's some way off. Sir Clive Sinclair has promised to provide them. But remember his Black Watch, C5 trike, Microdrive and take his promises with a sack of salt.

Setting up the dish isn't as easy as the glossy brochures may suggest. You may well need planning permission, especially if you try and put it on the roof. Westminster Council in London is now getting tough on this. And is your roof strong enough? What happens when the wind blows? A large dish is like a sail and needs anchoring, preferably with concrete. Garden dishes will be fine for country cottages (provided the neighbours don't complain about the ugly erection) but will usually be a no-no for city dwellers. The satellites in orbit over the Equator are uncomfortably low in the sky when sighted from Britain – betwen 24° and 31° for London and lower in the North. Unless you are lucky, there will be a house, tree or office block in the way. The golden rule is to check BEFORE buying.

The larger the dish, the more gain it offers on signal received but the more critical the alignment. The half-power beamwidth in degrees is 1.78/Diameter at DBS frequencies of around 12 Ghz. So for a 0.9 metre dish the beamwidth is just under 2 degrees and pointing errors should be within 0.5 degree. Compare that to the "good enough for jazz" alignment of ordinary TV aerials. A larger dish, of 1.8 metres diameter is even more critical. The half-power beamwidth becomes 1 degree.

The elevation depends on where the satellite is in orbit and where the receiving station is. To minimise the effects of light loss, satellites are put to the West of the viewer. The further to the West, the lower the angle in the sky. The further from the Equator, the lower in the sky also.

American TV station Cable News Network reaches Europe by a clever and expensive trick. Normally the US and Europe don't share programmes from a single satellite, because the beams aren't wide enough. The signal for Ted Turner's all-news station CNN is beamed up from Atlanta, Georgia in the 6 Gigahertz C band to the spare channel on the Atlantic Ocean Intelsat communications satellite at 27.5 degrees West over the Equator. On board the satellite the signal is changed in frequency to 11 gigahertz and "cross strapped" to another transponder on the same satellite. This beams it down to earth in the direction of Europe. The system is expensive because it "sterilizes" two half channels. The C band down link and K band up link are idle.

WHAT UNISAT WANTED TO CHARGE AND WHY

Originally the British DBS service was to be two channels, of 240 watts transmission power each. The price being quoted to the BBC was £24.4 million per year over seven years. The Group of 21 planned a three channel service, still with 240 watt transmitters. The price was put at a staggering £80m a year.

It took Unisat three years to talk to the press and explain the pricing structure. By then it was too late to save the project. But for the record: Unisat said the cost of providing a three channel service could be anything between £40 million and £80 million a year, spread over 10 years. The £80m is for three satellites, two in orbit and one on the ground. That gives 95 per cent probability of service without interruption. The £40m budget service would use two satellites, one in orbit and one on the ground. It gives only 75 per cent probability of uninterrupted service.

Probability is measured by estimating what will happen if there are one hundred satellites in orbit for ten years. The 95 per cent figures means 95 satellites birds will still be working after ten years, and so on.

Eclipses are the biggest worry. The solar panels stop generating. The orbital DBS slots (31 deg. West for Britain and Ireland; 19 deg. West for France and Germany) are chosen so that these eclipses will happen in the middle of the night, when no-one is watching television. They happen 88 times a year, in two clusters of 44, each eclipse lasting between two minutes and 90 minutes. No satellite can carry enough batteries to bridge the gaps so the microwave amplifiers go cold. This can cause premature failure, as on the Japanese satellite on which amplifiers from Thomson in France gave up the ghost.

Other firms which won DTI licenses are moving only slowly. BT is buying Thorn EMI out of both Swindon and Coventry. BT already has a stake in Aberdeen, Ulster and Merseyside. BT will become the major cable operator. But most of BT's systems will still be traditional tree and branch. Cable has become stale news. No one is interested in interaction. The public wants wall-to-wall programming. Technobuffs are currently much more excited about satellite. And delivering signals by satellite certainly makes more sense than digging up Britain or defacing it with slung wires – at least in areas where homes are widely space and the cable runs must be long and expensive or ugly.

WHAT COMES DOWN FROM THE SKY . .

The signals which come down from the sky are in the SHF band at around 11 or 12 gigahertz and in FM (Frequency Modulation) instead of AM (Amplitude Modulation) as used for terrestrial broadcasts in the UHF band. Circuits built into the dish aerial (a Low Noise Converter) amplify the very weak signal and drop the frequency to around 1 gagahertz (905 – 1750 MHz). This signal is then fed to a receiver unit which sits on top of an ordinary domestic TV set.

The receiver converts the FM, 1 GHz signal into a form which is usable by an ordinary domestic TV set. The NEC receiver for instance, can put out either a UHF signal which feeds direct into the aerial socket of a domestic set or it can put out composite video signal of the type which normally feeds out from the video recorder into the video sockets of a TV monitor set. The important point is that if the satellite is sending down a PAL signal it will emerge from the set top receiver still in PAL format. Likewise an NTSC signal stays as NTSC and SECAM remains SECAM.

All the English language cable channels coming off Intelsat and Eutelsat F-1 are in PAL format, so a satellite receiver can plug directly into a PAL receiver as used throughout most of Europe. Minor differences between different PAL formats (PAL I in Britain and PAL B/G elsewhere) do not matter if the signal is handled in composite form and are ironed out by switch settings on the receiver when the signal comes out as remodulated UHF. Sky Channel is PAL but scrambled. The French programme TV 5 is in SECAM. Although Ted Turner's Cable News Network orginates in the USA as NTSC, it is converted into PAL before beaming up to the satellite. This is why a range of cable programmes can by easily received by anyone with a suitable dish system.

SATELLITES

The technology sprang from a scientific proposal made by a sci fi writer, Arthur C. Clarke, author of "2001" and "2010". In the October 1945 issue of Wireless World, Clarke wrote an article which is well worth reading even today. He explained how conventional "terrestrial" TV and radio stations can only serve a very limited area. This is especially true for television, because TV signals need a wide frequency band (around 5 or 6MHz) and the only practical way to carry this band is on high frequency radio waves (of several hundred MHz.)

Because high frequency radio waves travel in essentially straight lines, and like light – do not bend round corners, receiver aerials should in theory have a direct line of sight on the transmitter aerial. The earth is round, so a short transmitter aerial is over the horizon of hills or buildings. In practice there is a little latitude. Signals bend or reflect. But the taller the aerial the wider the area of coverage.

It is clearly impossible to build transmitter aerial masts high into space. This is what led Arthur C. Clarke, who had been blitzed by German V2 rockets, to propose the idea of a transmitter in space. In his Wireless World article Clarke explained how a radio relay station could be made to sit, apparently stationary in the sky, by putting it into an orbit with a radius of 42,000 kilometres. This is equivalent to a height of around 36,000 kilometres above the Equator. At that height an orbiting craft will be moving around the earth at exactly the same speed as the earth itself rotates. So it will appear as if stationary above a fixed spot on the Equator. It thus behaves as a very tall transmitter aerial – without a mast.

This is now known as a geostationary satellite, in a Clarke orbit. At the time he wrote: *"Many may consider the solution proposed in this discussion too far-fetched to be taken very seriously. Such an attitude is unreasonable as everything envisaged here is a logical extension of developments in the last ten years – in particular the perfection of the long-range rocket of which V2 was the prototype. While this article was being written, it was announced that the Germans were considering a similar project, which they believed possible within 50 to 100 years".*

The first geostationary satellites went into orbit in the mid-60s, and were used to transmit live TV pictures from the Olympic Games in Japan. On board each satellite there is a bank of receivers and transmitters, powered by solar panels which take light from the sun.

A ground station beams radio signals up to the orbiting satellite where they are received, changed in frequency, amplified and transmitted down to earth again for ground station reception. The receiver and transmitter relay system is called a transponder. One satellite can "see" almost half the surface of the earth. So three satellites can broadcast to the whoe world, except the polar ice caps.

SOLAR POWER

Although solar power is free, the panels must be large. So power is at a premium. Only a few kilowatts are available. so the transmitters run on a few tens of watts each instead of the kilowatts used for terrestrial broadcasts. The frequencies used are in the gigahertz (1000 megahertz) range, because these frequencies are of little use for terrestrial broadcasting. They very closely resemble light and are easily absorbed by tha atmosphere. The wavelength is close to the size of a water droplet.

The gigahertz band can be used for satellites because the signals coming down from space need travel through only a relatively short atmospheric run. The air thins rapidly above the earth's surface. But they are still very weak when they arrive. They must thus be gathered by a dish, which focusses them onto a collector – like radar signals. The signal obtained is still of very low strength and must be processed by a low noise amplifier (LNA) which boosts signal strength without adding random noise. It also lowers the frequency so that the signal can be carried by cable. Otherwise waveguide plumbing is needed.

Early satellites transmitted such low power that a dish tens of metres wide was needed. Some Earth stations are still of this size. These large dish receivers are operated by telecommunications bodies, like BT and other national PTTs or Post Offices. Modern satellites broadcast at higher power (up to a few tens of watts) and earth station electronics have improved. So dishes of a few metres suffice. The plans for Direct Broadcasting by Satellite rely on much higher transmitter powers, of up to 200 watts. The signals can then be received on small dishes, less than one metre in diameter. But in each case the dish must be accurately aligned on the satellite, to within a fraction of a degree, and it must have an unobstructed view. Almost anything that blocks light will block gigahertz radio waves, including rain or leaves on trees. There is a world of difference between erecting a UHF TV receiver aerial and installing a satellite dish. This is something that can come as a nasty surprise to anyone without electronic knowledge who buys on the strength of some of the advertisements which offer home systems. They make it all sound far too easy.

ESSENTIAL

Satellite links are now an essential part of broadcasting and telecommunication technology. We no longer have to wait for film or video tape to arrive from abroad by courier before seeing foreign news pictures. Vietnam was the first war to be televised live. It's what finally stopped the war. People saw what was going on.

Telephone calls made around the world are sent either by submarine cable

or satellite, depending entirely on how much traffic is already running down the lines. The caller does not know how the signals are travelling, only that there are fewer delays in getting through because more circuits are available. Conferences are conducted by closed circuit television links which rely on satellites. It is far cheaper than travelling across the world just to talk.

Some business premises are installing their own dish aerials, to communicate with overseas branches or customers via a satellite channel leased by the hour. This is how the US Embassy in London can communicate on a private circuit with the White House in Washington. Most businesses hire the use of a dish aerial, for instance from BritishTelecom. This is how the Economist and Financial Times publish in more than one country at the same time. They transmit the text via satellites.

It is also how cable stations get their programmes. It is obviously impractical for each cable station to have its own studio and telecine equipment, with full library of all the films and tapes shown as premium entertainment. It makes far better sense for all the special programmes to come from one or more central source points. The easiest way to distribute the signals from these "programme providers" is by satellite. The cable station has its own dish aerial or takes a feed from BT.

INTELSAT PROGRAMMES

1. Premiere* – twelve hours a day top quality premium movies. Supplied by the major Hollywood studios. Thorn EMI Screen entertainment and the best from independent producers. Six or seven different movies a day, a minimum of 18 new movies introduced to the service each month.

2. Screen Sport* – every kind of sporting action, from the four corners of the world. Including top first division football not available on BBC or ITV, afternoon to midnight daily.

3. Chidrens Channel* – look and learn mixed with lots of film and cartoon fun. A guaranteed hit with kids of all ages.

4. MirrorVision – continuous programming 14 hours daily, presenting Top Box-office feature films, including daytime dramas, serials, documentaries, also classic movies of yesteryear. Plus late night films for the more discerning adult viewer.

5. Cable News Network† – 24 hour US and international news coverage. The first all American European channel.

6. Lifestyle – women's programmes.

7. Cabletext – a complete on-screen programme guide – news; weather; general information. Write in with birthday messages for family and friends.

⅛ These channels comprise the Galaxy Television Package.

† Live from the USA.

MAXWELL PLANS

Robert Maxwell plans to use a French direct broadcast satellite to beam English language programmes into Britain. The French satellite TDF-1 will hang at the 19 deg W slot allocated to France. If and when Britain gets its own DBS service, signals will come from the 31 degree West slot allocated to Britain.

So far the only signals to receive are cable fodder coming from Eutelsat F-1 and Intelsat V. Intelsat hangs at 27.5 degrees West and Eutelsat at 13 degrees East. For good reception a dish aerial must be aligned on its invisible target with an accuracy of better than one degree. There is no way that existing dishes will be able to receive Maxwell's Channel, unless they are realigned to exclude other channels or equipped with an expensive motor drive to turn the dish. The alternative is to use two dishes, which is equally expensive. The IBA, which is trying to organise a UK DBS service, worries that by the time it gets off the ground at the end of the decade, anyone interested in DBS will already have aligned their aerial on the French satellite to receive Maxwell's programmes. But it is not even as simple as that.

When Maxwell signed with the French his office admitted that they had not thought about the TV format to be used for transmission. Signing the £6 million year rental deal was first priority. This may prove an expensive or embarrassing mistake for Maxwell.

The French and German broadcasters and governments have said they will use the completely new MAC (multiplexed analogue components) system for DBS. MAC was developed in Britain by the IBA. Europe likes the idea of going with MAC because patents on the system may provide protection against a flood of low cost imports from the Far East – just as the PAL patents have shielded the European TV industry for nearly 20 years.

So far there aren't any receivers which can handle MAC signals. There aren't even any chips for the manufacturers to use in MAC sets. They are due from ITT and Mullard. Whereas the French and German governments may be prepared to subsidize their satellite service for a few years to help get MAC established, Robert Maxwell certainly won't want to do the same. As his main target audience is Britain, he will have to think PAL. But that means that French audiences won't be able to receive signals from their own satellite.

The European Broadcasting Union has clear views on the matter. It will insist on Maxwell using the MAC transmission system from the French satellite. The EBU chose MAC as the future standard for direct broadcasting TV by satellite in Europe, to create a market for new TV sets and so help the European electronics industry.

Both Michel Oudin of SFP, Societe Française de Production, and Jean Caillot, International Manager of the nationalised French electronics company, Thomson, have confirmed to me that French DBS bird TDF-1 will be transmitting only MAC signals. There will be no room on the satellite, say Oudin and Caillot, for an extra transmitter to broadcast programs in the conventional UK PAL standard. George Waters, Director of the European Broadcasting Union technical centre in Brussels is equally blunt. "There is no question about it. Robert Maxwell will have to use the MAC system. It is a requirement of the licences to transmit from satellites in Europe. This was done to support the European receiver industry. We know there will be only a very few receivers for quite some time. France and the EBU are quite clear on this. Even if Robert Maxwell isn't aware of this, someone in his organisation must know and should tell him."

The problems with Ariane rockets, and the change in French government, may well save Maxwell's bacon by delaying the French DBS project. Maxwell still hopes for a satellite launch this winter and the chance to start broadcasting next spring. "We would regret any delay," said Maxwell's office, after Ariane Flight 18 failed in May. Earlier Maxwell had dismissed reports that the new conservative French government was cancelling his contract signed by the old socialist government. The repor was, he said, "complete fabrication", adding "I have a contract with the French government and am sure they will honour it". Under the circumstances he may have had a lucky break.

The satellite lost with Ariane Flight 18 was an Intelsat V communications craft. It was scheduled to start operation on 15 August at 307 degrees East and carry mainly private videoconference, facsimile and data links, for instance between newspapers wanting to publish simultaneously in several countries. There will now be pressure on ESA to put new communications satellites ahead of TDF-1 in the launch queue. This would delay TDF-1 and DBS from France.

Broadcast engineers' secret fear is that if TDF-1 goes up, Europe may soften and allow Maxwell and others to use PAL instead of MAC. If this happens MAC may never be used in Europe.

In Japan there is now a limited broadcast service intended for private reception – Direct Broadcasting by Satellite. The intention is to reach areas of the mountainous country which are cut off from normal terrestrial TV. Both Germany and Japan plan to launch DBS craft. But failures in the rocket launchers have upset their plans. In developing nations, like India and Africa, satellites make it possible to reach remote villages and townships. China may launch its satellites now that the European (Ariane) and American (Challenger and Titan) rockets have been grounded.

The original scheme, announced in March 1982, was for the BBC to run a DBS service in Britain. Then the BBC got cold feet over cost and the government tried to interest the ITV companies. They also pulled in some independent firms, like Thorn-EMI, to form what became known as the group or club of 21. Even with costs shared between so many parties, plans for DBS were scrapped. This was largely because the government insisted that any DBS service for Britain must use a British satellite built by a consortium of British Telecom, British Aerospace and GEC-

CATV In Europe (courtesy of CIT research)

Marconi. The prices quoted by this Unisat consortium were far too high; a rental of around £25 million a year for two channels. This later rose to £80 million for three channels.

Unisat made enemies of the press and industry. Potential customers tried to but elsewhere but the government said no. The government also said no to an injection of pump-priming funds. So the BBC, IBA and private companies said no to DBS. The government has now climbed down and asked the IBA to try again, without the obligation to buy British. Unisat has faded from the picture. The BBC is now being used for work done by the consortium before it opted out. It's a messy business.

Although there is still no UK DBS, several thousand people are receiving extra TV programmes direct from satellites. They are receiving material intended for reception, and then relay to subscribers, by a cable station. This follows a craze in America for backyard dishes. You buy a large dish, with LNA and frequency down-converter, erect it in the backyard and feed the output to a TV set. In return for the several thousand dollars it costs, you get cable programming free, without the need for any cable connectoin. Around a million people in the US are plugged into satellites this way.

RELAXATION OF LAWS

Until recently the Wireless Telegraphy Acts made it an offense to do likewise in Britain. The Government wanted to discourage people from erecting their own backyard dishes, because it undermined the grand plan for DBS. In the summer of 1985 the government relaxed the law, so that it is now possible for householders to buy an aerial system and

A GUIDE TO EUROPEAN SATELLITES

EUTELSAT F1

ORBITAL SLOT: 13°E
OPERATOR: Eutelsat
FREQUENCIES: Ku Band
BEAM: Most of Europe for TV relay, including Scandinavia and North Africa. Business service (SMS) beam is smaller.

INTELSAT 27.5°W

ORBITAL SLOT: 27.5°W
OPERATOR: Intelsat
FREQUENCIES: C and Ku Bands
BEAM: Steerable West and East spotbeams

INTELSAT 60°E

ORBITAL SLOT: 60°E
OPERATOR: Intelsat
FREQUENCIES: Ku Band
BEAM: Steerable West and East spotbeams

INTELSAT 1°W

ORBITAL SLOT: 1°W
OPERATOR: Intelsat
FREQUENCIES: Ku Band
BEAM: Steerable West and East spotbeams

TELECOM 1B

ORBITAL SLOT: 5°W
OPERATOR: DGT (Direction Generale de Telecommunications)
FREQUENCIES: Ku Band
BEAM: Western Europe and overseas French Departments

EUTELSAT F2

ORBITAL SLOT: 7°E
OPERATOR: Eutelsat
FREQUENCIES: Ku Band
BEAM: See Eutelsat F1

EUTELSAT F4

ORBITAL SLOT: 10°E
OPERATOR: Eutelsat
FREQUENCIES: Ku Band
BEAM: See Eutelsat F1

TDF-1

ORBITAL SLOT: 19°W
OPERATOR: French government
FREQUENCIES: Ku Band
BEAM: Most of Europe, centred on France.

TV-SAT

ORBITAL SLOT: 19°W
OPERATOR: Deutsche Bundespost
FREQUENCIES: Ku Band
BEAM: Most of western Europe, centred on West Germany.

receive the signals intended for cable stations. A licence costs £10. It's a one-off, not annual, fee. By May 1986, only 1300 people had paid. Most people don't bother.

The viewer is also obliged to pay fee to the programme providers. There are around 20 programmes to watch in Europe and the fee for a full house would be at least £5 a week. In practice it is hard to find out who to pay and how much. So, again, dish-owners just don't pay. Having spent up to £2,000 on a receiving system, they feel they have laid out enough. But nothing is for nothing and the programme providers will have the last laugh. They plan to start scrambling their signals. then only those viewers who pay for a decoder will be able to watch. The fine print in satellite system adverts often warns of this, as a legal safeguard. It is unlikely that many customers take much notice. They stand to be sorely disappointed when scrambling starts. It has already started in the US, where Home Box Office asks $12.95 a month for decoder. And that's for just one channel. Dish sales in America have slowed dramatically. The same thing will happen in the UK once scrambling begins – unless the programme providers can agree a common scrambling method and rent decoders at a price which is fair all round.

EUTELSAT PROGRAMMES

PROGRAMME	COUNTRY OF ORIGIN	TYPE OF PROGRAMMING	DECODER REQUIRED	COLOUR SYSTEM
1. TV5	France	Entertainment	No	SECAM
2. RAI	Italy	Entertainment	No	PAL
3. Teleclub	Switzerland	Movies (German)	No	PAL
4. SAT1	Germany	Entertainment	No	PAL
5. 3SAT	Germany	Entertainment	No	PAL
6. NewWorld Chan	Norway	Religious	No	SECAM
7. Film Net	Holland	Movies (English)	No	PAL
8. Europa	Holland	Entertainment (English)	No	PAL
9. RTL-Plus	Luxembourg	Entertainment (German)	No	PAL
10. World Net	U.S.A.	U.S. Information Agency	No	PAL
11. Music Box	UK	Seven days a week of solid rock, the beat goes on eighteen hours a day. Catch the weekly chart shows and concerts. Watch for all the pop news, specials and face to face interviews with top stars.	No	PAL
12. Sky Channel	UK	Action; adventure; comedy and cartoons; current affairs; classic TV features for all the family.	Yes	PAL

CONTROLLING THE MAINS

BY G.R. HYNES

Two control circuits for mains applications

Mains control projects have always been popular for hobbyists as they provide, in most cases, a cheaper practical device than is available in the high street. Here we have two designs – a novel touch-dimmer project and a useful delay switch.

DELAYED MAINS SWITCH

THE first unit to be described will switch off any mains powered equipment (up to a maximum of 1KW) after a pre-determined time (from between 15 minutes to 2 hours) in eight, 15-minute steps. The circuit was originally designed for a member of my family who enjoys watching TV in bed. Usually she falls asleep and unless she wakes up it can mean that the TV is on all night.

Apart from annoying the rest of the family it can be dangerous and is a sheer waste of electricity.

Using this unit, however, she can set the delay she wants and nod off without feeling guilty. The same could apply to anyone who enjoys listening to the radio when in bed.

Another application could be for children who are frightened of the dark and need a light on when they go to bed. The delay is set to give the child enough time to fall asleep before the light is switched off.

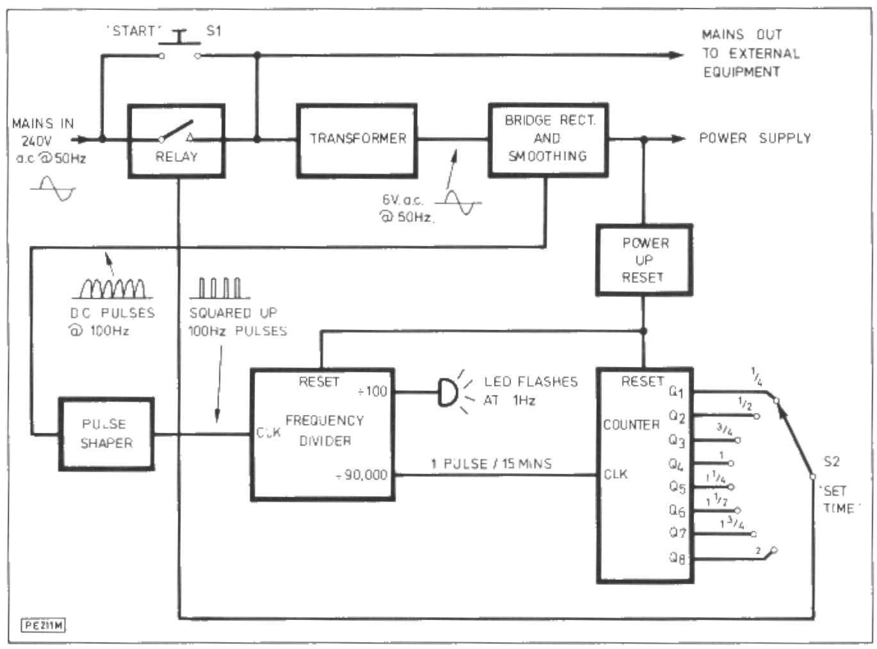


Fig. 1. *System block diagram*

TIMING METHOD

When long time delays are required the use of a CR time constant becomes undesirable due to the high values of capacitance and resistance that are needed. High value resistors are not readily available and have to be made up by connecting smaller values in series, leading to large quantities of resistors being used. The capacitors used must have a very low leakage current if wide timing errors are to be avoided. Electrolytics are very poor in this department. Smaller values of capacitance and resistance can be used if they determine the frequency of an oscillator whose output is fed to a counter such that after N pulses, an output pulse is produced. However this requires a known stable oscillator frequency and needs accurate setting up. Improved stability and accuracy can be achieved by using a crystal, but at greater expense.

The method employed by this unit, however, is very accurate and requires no setting up since it utilizes the 50Hz cycling of the mains.

SYSTEM OPERATION

The system block diagram is shown in Fig 1. Once the delay required has been set by S2 and the equipment to be switched has been connected to the unit, the circuit is started by pressing S1, thus applying mains power to the unit and equipment. A 'power up' signal is generated to reset the frequency divider and counter ensuring all counting starts from zero. The counter's outputs go low and the relay is energised closing its contacts. SW1 can now be released. Power is now maintained by the relay.

The mains voltage is stepped down by the transformer and is full wave rectified producing 100Hz dc pulses. A smoothing circuit provides a dc voltage to power the unit. The 100Hz pulses are passed through a shaping circuit before application to a frequency divider which divides them by 90,000 producing an output pulse every 15 minutes. The divider also generates a 1Hz signal to drive an LED indicating the unit is on.

The divider output is fed to a counter such that Q1 goes high after the first pulse, Q2 after the second etc. When the selected output goes high, the relay is de-energised switching off the unit and equipment connected to it.

THE CIRCUIT

The circuit diagram is shown in Fig. 2. Mains power is passed to the unit and external load by the contacts of SW1 and RLA1 which are wired in parallel. SW1 need only be pressed for an instant enabling a dc voltage to be established and RLA1 to be energised to maintain power to the unit and load.

COMPONENTS

RESISTORS

R1	47K
R2,R3	10K (2 off)
R4,R7	1k (2 off)
R5	1M
R6,R8,R9	100k (3 off)
R10	4K7

All resistors ¼W 5% carbon film.

CAPACITORS

C1	1000μ electrolytic
C2	2μ2 25v tantalum

SEMICONDUCTORS

REC1	W005
D1,D12	1N4001 (2 off)
D2–D10	1N4148 (9 off)
D11	TIL220 LED or similar
TR1	2N3904 or similar
TR2	2N3906 or similar
IC1	4024 CMOS
IC2	4001 CMOS
IC3	4040 CMOS
IC4	4017 CMOS

MISCELLANEOUS

T1 Mini transformer 6v, 6VA; RLA1 Relay 6v, 70 coil, 240v ac 6A contacts (Maplin FJ42V); SW1 d.p.d.t. switch biased one way, 240v a.c. 6A contacts (RS 317-049); SW2 1-pole 12-way rotary switch; FS1 5A fuse; FS2 100mA fuse; p.c.b.'s, dil sockets, chassis fuseholder, panel fuseholder, unswitched mains socket, 6A mains cable, knob, case, plug, nuts, bolts, wire, etc. (See PCB Service)

The mains voltage is stepped down by transformer T1 to 6v ac at 50Hz REC1 full wave rectifies the ac to produce 100Hz dc pulses which are passed to the smoothing capacitor C1 via D1. D1 isolates the pulses from the steady dc voltage of about 7–8v across C1 which provides the supply for the circuit. R4 is included to discharge C1 rapidly after switch off. C2 and R5 provide a 'power up reset' signal for IC3 and 4 ensuring all counting starts from zero.

A pulse shaping circuit formed by R1, R2, R3 and TR1 squares up the slow edged rectified pulses before applying them to the divider circuitry. The divider is in two stages. The first divides the 100Hz pulses by 50 producing a 2Hz output. It is formed by IC1 – a 4024 7 stage binary ripple counter. D2, 3, 4 and R6 connected as a 3 input AND gate and IC2(a) and (b) – two gates of a 4001 NOR connected as a bistable. It works in the following way.

100Hz pulses from the shaper are fed to the CLK input of IC1 and to pin 1 of IC2. Pin 5 of IC2 is normally held low by the AND gate, pin 3 of IC2 is therefore low thus holding RESET of IC1 low, allowing it to count.

The count on IC1 increments on the negative edge of each pulse. On the negative edge of the 50th pulse Q2 AND Q5 AND Q6 all go high so that pin 5 of IC2 goes high. Since pin 1 of IC2 is now low, pin 3 of IC2 is forced high, thus resetting IC1. Q2, 5 and 6 are all forced low as is pin 5 of IC2. When the pulse on pin 1 of IC2 goes high again pin 3 is forced low and IC1 is able to count once more. This method of resetting IC1 was used because it provides a long, reliable reset pulse.

The 2Hz output from the first stage is fed to the second stage formed by IC3 – a 4040 12 stage binary ripple counter. D5, 6, 7, 8 and R9 connected as a 4 input AND gate and IC2(c) and (d) connected as a bistable. This stage operates in exactly the same way as the first except it divides the 2Hz input by 1800 producing an output pulse every 15 minutes. It also has a divide by two outputs to drive an LED via current limit resistor R7 to indicate that the unit is on.

An OR gate formed by D9, 10 and R8 ORs the 'power up reset' signal with the reset signal from pin 11 of IC2. 'Power up reset' is also connected to pin 15 of IC4 – a 4017 counter. IC4 counts the 1 pulse per 15 minutes produced by the divider.

On power up outputs Q1 to Q8 of IC4 are forced low. These outputs are connected to the contacts of a rotary switch SW2 which selects the time delay required. The pole of SW2 is connected to the base of transistor TR2 via resistor R10. When the selected output is low TR2 is on and RLA1 is energised, when high ie after the required delay, RLA1

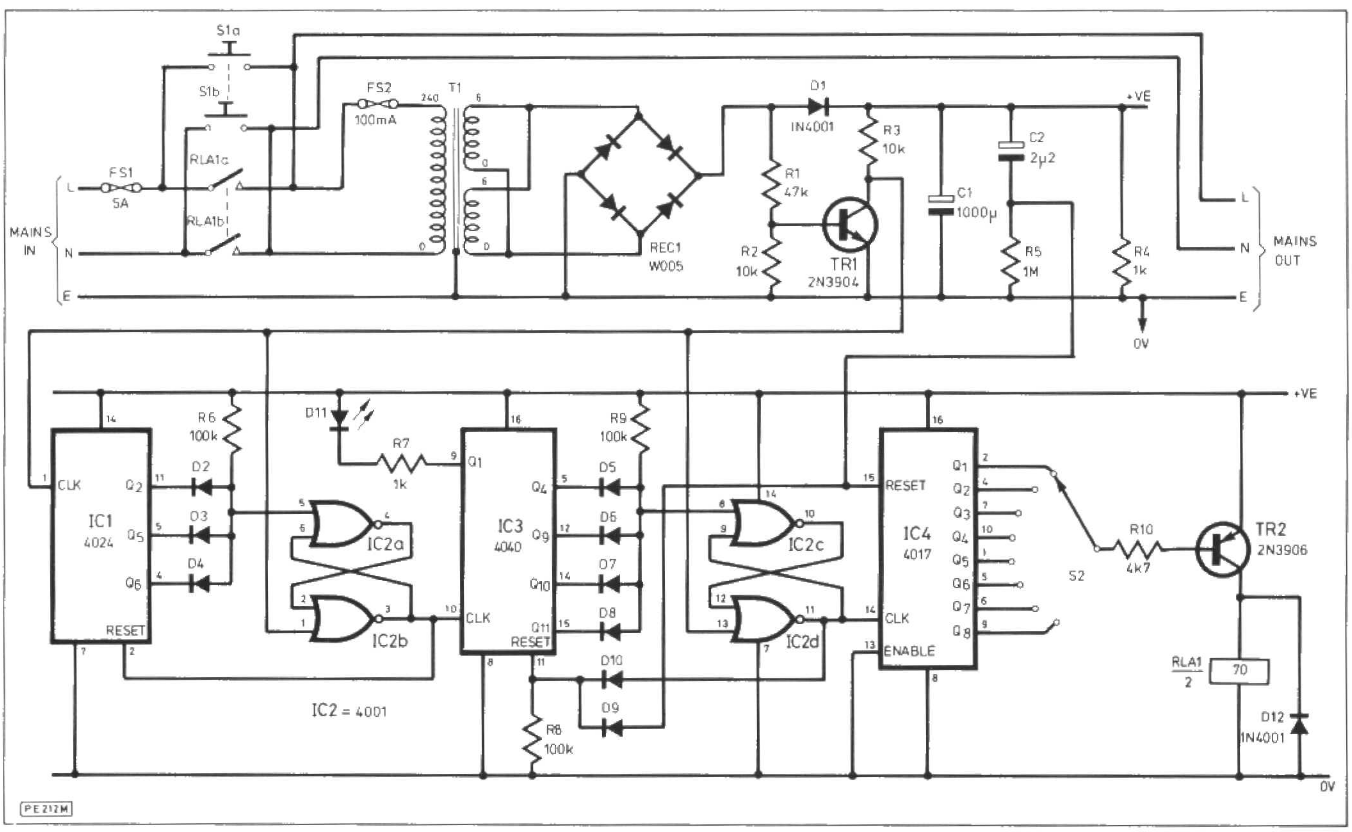


Fig. 2. *Complete circuit diagram*

is de-energised switching off the unit and load. D12 connected across the coil of RLA1 protects TR2 from the voltage surge generated when it is de-energised.

CONSTRUCTION

The component overlay and wiring is shown in Fig. 3. The relay is mounted on a separate pcb for two reasons. Firstly it avoids running tracks at mains potential close to low voltage dc tracks and secondly it is easy to change the layout of the pcb if necessary to accommodate a different relay to the one specified.

The tracks on the relay board can be thickened up using solder to increase their current carrying capability.

Construction of the main pcb is straightforward. The ICs used are CMOS types and the usual precautions should be observed. The use of dil sockets is recommended. Special care should be taken to ensure that diodes, capacitors, transistors and ICs are connected the right way round.

The prototype was squeezed into a die cast box measuring 120mm x 95mm x 50mm, but the use of a plastic case is recommended for safety reasons. If a metal case is used it must have an earth connection to it. To avoid errors when wiring SW2, use a colour code system. Also be sure to connect LED D11 the right way round. All mains wiring except that to the transformer should be rated at 6A and mains connections should be sleeved.

TESTING

Once you have completed construction and you have checked for errors the unit is ready to be tested.

Begin by selecting a delay of 15 minutes and with no load connected to the unit plug in and press SW1. You should hear RLA1 energise and the led should start to flash once a second. If not switch off and make the usual checks for errors.

If all is well, after 15 minutes the relay will de-energise and the led will stop flashing. The unit can now be tested with an external load such as a lamp, TV etc on all eight ranges. PE

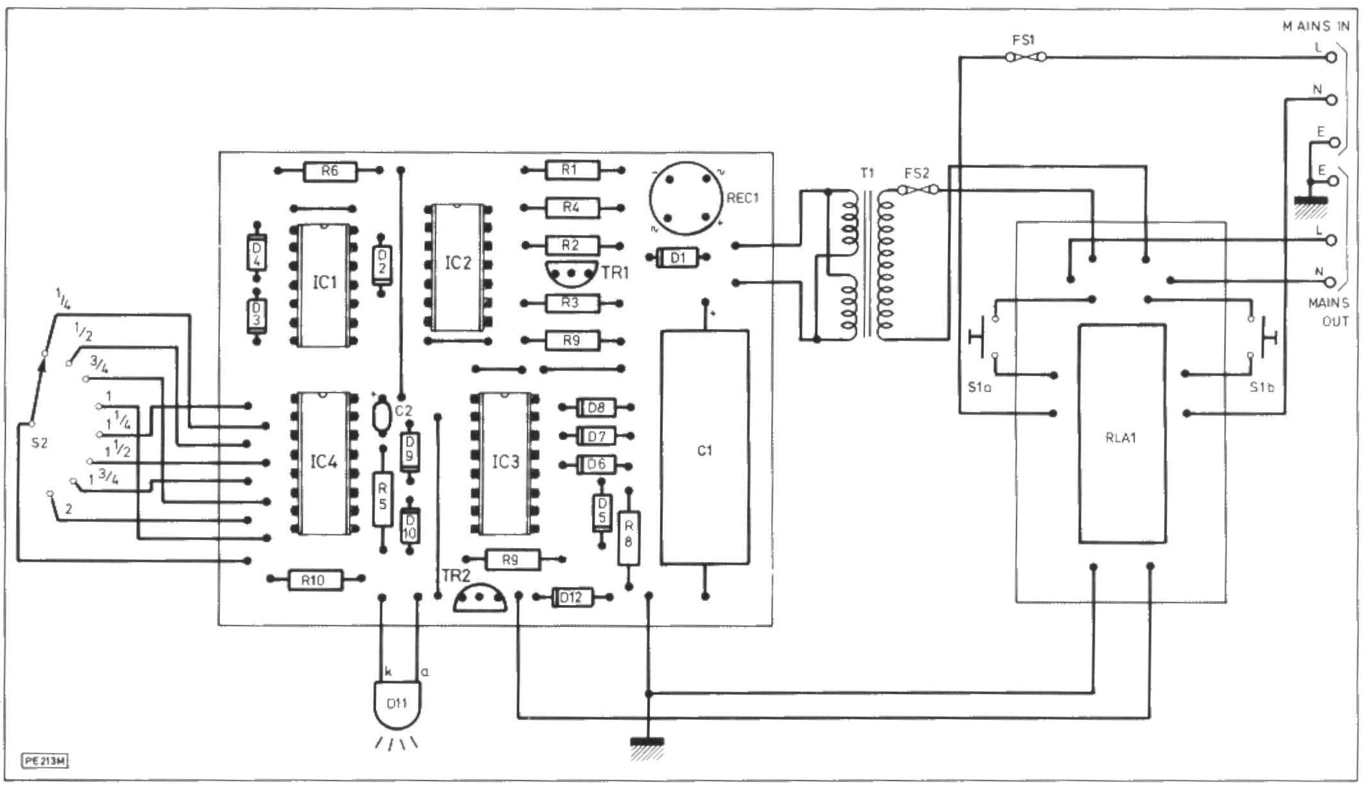


Fig. 3. *Wiring details, p.c.b. design and component position details*

TOUCH DIMMER

THE second of our 'mains' projects is a totally solid state dimmer. There are no mechanically moveable parts such as switches or potentiometers. Instead the unit is controlled by a single touch sensor. The circuit is based around the Siemens S576B dimmer/switch i.c. which in conjunction with a few external components distinguishes between turn on/off and dimming commands by the length of time the sensor is touched, controlling the power delivered to the lamp accordingly.

The unit was designed for a maximum load of 400W which should be sufficient enough for most household lighting applications.

TOUCH CONTROL

A short touch of between 50 and 400ms on the sensor turns the lamp on or off depending on its preceding state. If the touch period is greater than 400ms the lamp will begin to cycle between maximum and minimum brightness. A full cycle ie from maximum to minimum brightness and back again takes about 7 seconds. The finger is removed from the sensor when the lamp is at the required brightness. This set level is memorized and remains stored even if the lamp is switched off. Next time it is switched on the lamp will automatically light at the stored brightness level. The unit will tolerate mains supply interruptions of up to one second before losing its memory.

DIMMING

The IC determines the brightness of the lamp by controlling trigger pulses applied to the gate of a triac. By varying the point in the mains cycle at which the triac is triggered into conduction the average power delivered to the lamp can be controlled. This is known as Phase Angle Control. Fig. 1 shows waveforms that demonstrates the principle.

The sooner the triac is triggered the greater the power delivered and the brighter the lamp. The later it is triggered

the smaller the power delivered and the dimmer the lamp.

THE CIRCUIT

The circuit diagram is shown in Fig. 2. The unit is protected by a 2A fuse which may be reduced in value for smaller loads eg 1A for a 200W load.

COMPONENTS

RESISTORS

R1	1M5
R2	100
R3	1k/1W
R4–R6	4M7 (3 off)

All ¼W ± 5% carbon film (unless stated otherwise).

CAPACITORS

C1	100n 500v ac metallised polypropylene (Maplin)
C2	220n 500v ac metallised polypropylene (Maplin)
C3	100µ 25v electrolytic
C4	470p ceramic
C5	47n polyester

SEMICONDUCTORS

IC1	S576B Dimmer/ Switch (RS, Electrovalue)
SCR1	TIC226D Triac
D1	15v 400mW zener
D2	1N4007

MISCELLANEOUS

L1 3A RFI Suppressor choke; 20mm fuse, fuse clips, touch pad, d.i.l. socket, p.c.b. terminal block, blanking off plate, 25mm PVC pattress, nuts, bolts, wire, solder, etc.
The p.c.b. is available from the PE PCB service, order code PE123.

A 15v dc supply is derived from the mains by R2, C2, D2, D3 and C3 and is fed to +vss (pin 1) and −vdd (pin 7). R3 and C2 limit the current that flows through zener diode D1, which produces 15v half wave rectified pulses to charge smoothing capacitor C3 via D2. C5 is an integration capacitor and is connected to pin 3. R2 and C4 provide a filtered signal for synchronization of the internal timebase of IC1 with the 50Hz mains frequency. This signal is fed to pin 4.

Gate signals from pin 8 are fed to the triac, SCR1, via current limit resistor R1. Radio frequency interference generated by the triac switching transients is suppressed by choke L1 and capacitor C1. L1 acts as a high impedance and C1 a low impedance to high frequencies.

The touch sensor works by the 'Mains Hum' pickup principle and is connected to pin 5 of IC1 via R5 and R6, their high values protect the user from electric shock. R4 determines the sensitivity of the sensor.

CLK input (pin 2) is not used in this application and is connected to +vss. Nor is the Extension input (pin 6) which is connected to −vdd.

CONSTRUCTION

The component overlay is shown in Fig. 3. All components are mounted on the p.c.b. and construction is relatively straightforward. The use of a dil socket for IC1 is advisable. Triac, SCR1, is mounted flat on the board; a hole is provided in the pcb so that it can be held down firmly with an M3 nut and bolt.

The touch sensor (available from Maplin) is mounted in the centre of a blanking plate and is secured with an M3 nut and washer. The stud of the sensor passes through the centre of the pcb. The pcb is mounted on the stud by sandwiching it between a nut and washer

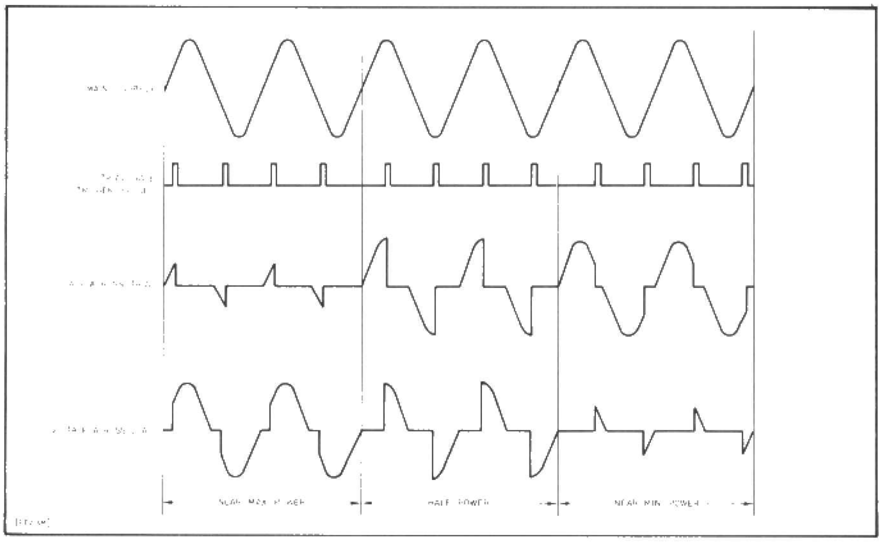


Fig. 1. *Typical phase angle control waveforms*

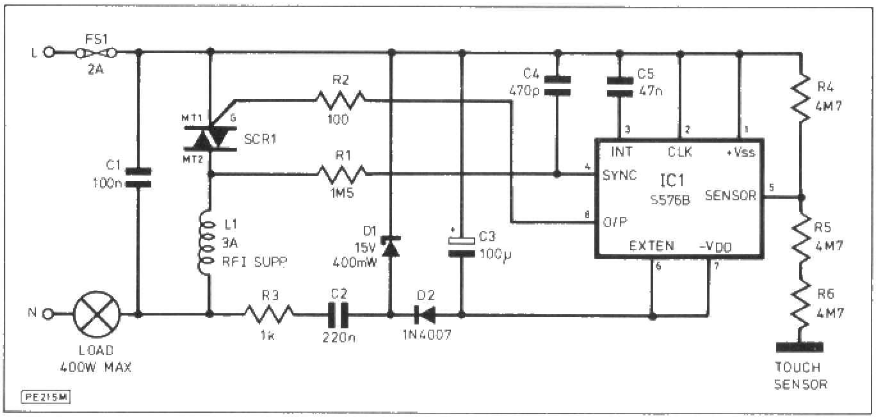


Fig. 2. *Complete circuit diagram*

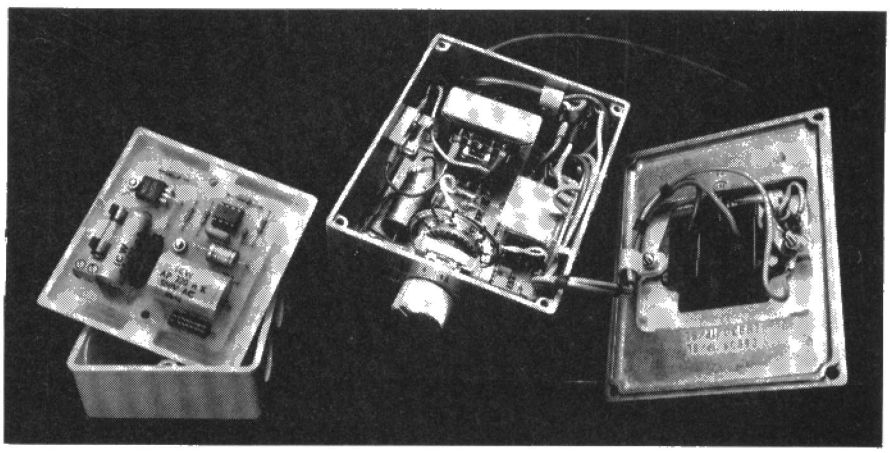


Photo.1. *Both projects – constructional details*

on the track side (to make contact with the central pad) and a nut on the component side to hold it in place. The holes at the edge of the pcb should be aligned with the holes on the blanking plate so that the securing screws can pass through.

The unit requires a 25mm deep pattress preferably made from PVC rather than metal to avoid the possibility of short circuits.

TESTING

When construction is complete and you have checked your work thoroughly the unit is ready for testing. ***When testing remember the unit is at mains potential and great care should be taken.*** Check that the lamp can be switched on and off and dimmed as described. If not switch off and recheck your work for errors. A slight buzzing sound may be detected coming from the choke – this is quite normal. Once you are satisfied that the unit is functioning correctly it is ready to be installed and is simply connected in place of your existing switch. During use the unit gets warm mainly due to the dissipation in R3 and SCR1. For loads of greater than 200W some form of heatsinking is recommended for SCR1. PE

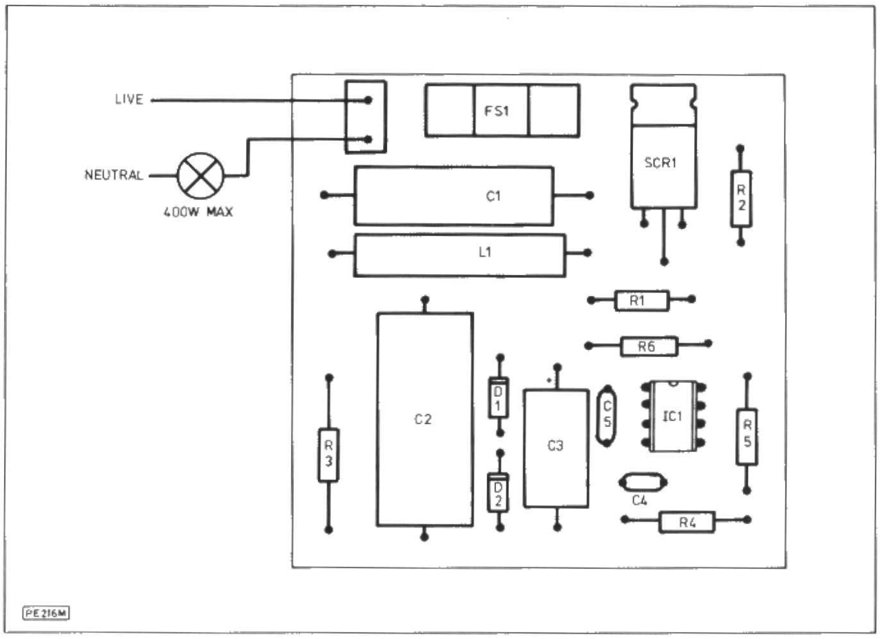


Fig. 3. *P.c.b. design and component position details*

PE BAZAAR

FREE READERS ADVERTS

Acorn electron computer, requires new U.L.A., otherwise good condition £30 plus postage. Mr A. Denby, 6 Ropewalk, Alcester, Warks B49 5DD. Tel: 0789 763502.

Magazines: PE 1972 to 1980, ETI 1974 to 1980. Will sell complete years at £2.50 plus parcel postage. B.C. Jackson, 85 Maple Grove, Ellesmere Port, S. Wirral. Tel: 051 355 9579.

Eidophon EP-8-50 Color, large screen ($200m^2$) TV projector with spares. Offers: Stefan Mehrl, Amselweg 15, D-8426 Hexenagger.

For sale (offers) 40 TV and radio valves (mixed) some boxed (Mullard, Mazda, Tungsram) types. Yunis Karbhari, 33 Manor Road, Blackburn BB2 6LU, Lancs. Tel: Blackburn 51553.

Brother electronic typewriter with RS232 port for computer use, £60. Spectrum power pack, £5. Mr R. Denney, 59 Four Acre Mead, Bishops Lydeard, Taunton, Somerset TA4 3NW. Tel: Taunton 432909.

Pye labgear televerta with preamp mains model no. CM6022RA, £6. Mr R. Denney, 59 Four Acre Mead, Bishops Lydeard, Taunton, Somerset TA4 3NW.

Wanted: any ORIC or ATMOS hardware, broke, or working. Also wanted Lego or Fischertechnik parts/ sets. J.J.H. Bull, Woodcroft House, Comeytrowe Road, Trull, Taunton, Somerset TA3 7NF. Tel: (0823) 82447.

Textronix oscilloscope 8 – trace 19MHz, £185. CRTs (new) D14/170GH D14/ 172GM, £35 each. Fast pulse generator, £55. Good condition. T. Haley. Tel: (01) 868 4221.

Transcendent 2000 synth complete and working, best offer over £140. Buyer collects. M.P. Abbott, 97 Norton Leys, Rugby, Warwickshire CV22 5RT. Tel: 0788 815873.

Colour bar decca EP685, ten patters bands 1345 RF/Video outputs 0 – 76dB Atten. £95. Mr J Pearce, 29 Shalgrove Field, Fulwood, Preston, Lancs PR2 3SX. Tel: 0772 8635695.

Wanted: MM4001 A1778/2 A1672 SM6256 BFW/SFS transistors or technical data also CX3500 solartron oscilloscope probe. Mr R Neale, 2 Salmond Avenue, Beaconside, Stafford ST16 3QP.

Wanted: circuit and service data for Moog 5330 satellite synthesiser. Mr R.S. Moore, 19 Raw Lane, Illingworth, Halifax HX2 8JD.

P/P weir maxired 761 0 – 30v ZA or 0 – 15v 4A stabilised meter output diagram, new condition £50. W.F. Barton, 39 Brendans Close, Hornchurch, Essex RM11 3UL.

Free Texas Magnetic Cards (for recently dead T.I.59) shared among all who send S.A.E. to me. Chris Finn, 11 Alexandra Drive, Southwood Park, Beverley HU17 8PG.

BBC Micro books and mags in good condition for sale. Tel: 0438 813732 (evenings).

Nickel cadmium cells, 2 packets of 10. 6.AH exministry, unused £20 each packet. Would separate pack to callers. A. Harrison, 477 Chickerell Road, Chickerell, Weymouth, Dorset DT3 4DQ. Tel: Weymouth 772513.

Weather satellite receiving system for Metersat and NOAA. Comprises antenna, LNA, converter, receiver, £300. S.A.E. details. D. Chapman, 6 Pickhurst Green, Hayes, Bromley BR2 7QT. Tel: 01-462 2178.

For sale: Philips DMM model PM521, £200. W.B. Glayzer, 27 Albert Road, Southport, PR9 0LF. Tel: Southport 0704 31153.

'Elite' episcope, little used, good working order, £20. L. Myers, 60 Primrose Road, London E18 1DE. Tel: 989 9643 (evenings).

New handcranked wee 'Megger' series 3 mark IV. AVO8 MK III multimeter A vomultiminor. AVO voltage multiplier. Offers. L.T. Cowell, 69 Crewe Road, Haslington, Crewe CW1 1QX. Tel: Crewe 581157.

Open University studies force sale. Over £30 new components plus many used electronic hardware. £15 o.n.o. Mr K. Harrison, 19 Zealand Park, Caergeiliog, Holyhead, Gwynedd LL65 3PQ.

Electronic owner needed for electric mini car. Spare batteries, motor, thyristors. G. Wapling, 6 Squires Road, Shepperton TW17 0LQ. Tel: Chertsey 64856.

BETTER USE OF SEALED NICKEL-CADMIUM BATTERIES

PART FOUR BY ROD COOPER

The ways in which NiCad dies

The concluding part of this fascinating series summarises the precautions to be taken when using batteries in projects

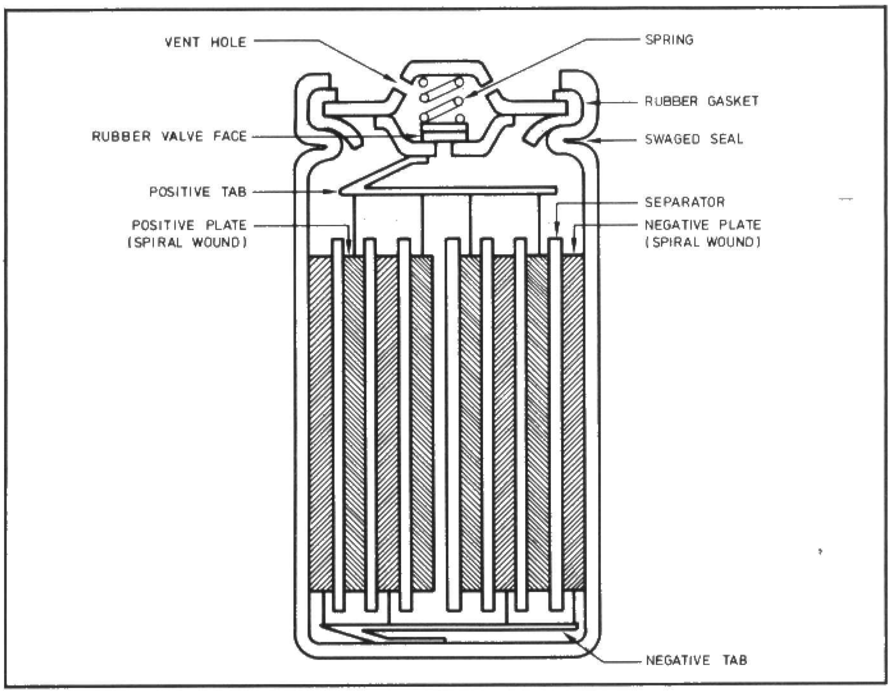
PART 3 dealt with premature failure of NiCads due to the water of reaction being lost via the safety vent as gases during accidental or unwitting abuse. Part 4 deals with premature failure caused by internal short-circuits, again caused by incorrect handling.

DENDRITE FORMATION

Unfortunately the Cadmium of the negative electrode of the NiCad cell is very slightly soluble in the electrolyte, which is usually based upon a solution of Potassium Hydroxide (KOH) in water, and this gives rise to the following problem.

During the recharging process, the dissolved Cadmium is plated out exactly as in an electroplating bath. However, the Cadmium that is plated out may not form smooth metal, but is likely to be deposited as a dendrite. A dendrite is a minute crystalline structure which can take different forms, but which may look like a tiny tree, with a main trunk and many spiky branches. The scale of a dendrite may be judged by the thickness of the branches, which are only a few microns thick. Dendrite formation is not exclusive to Cadmium, many other metals such as copper, silver and in particular zinc, also form dendrites, and this property is due to the pronounced crystalline structure of these metals.

Dendrite-induced failure is very puzzling to the user because it can happen quite quickly to cells with a previous good record, and because it is very hard to discover why failure has taken place.



There are two common practices which favour dendrite formation. Firstly, charging at a current which is too low for too long – i.e. trickle charging. Many standby applications such as burglar and fire alarms use trickly charging, but it is best to avoid it if possible. Recharging at the limit of the recommended rate (usually C/10) is less likely to cause trouble from dendrites. Secondly, using d.c. for recharging causes dendrites. If you use d.c. *and* trickle charging you get the worst possible combination.

You will be pleased to know that the electoplating industry has had a cure for dendrites for a long time, known as Periodic Current Reversal (p.c.r.). The technique was described in part 2 in the July issue, 'Better use of dry batteries' and consists of applying a short pulse of current in the opposite direction to the main charging current at regular intervals. The p.c.r. charger design given in this article makes an excellent charger for NiCd cells, with a few modifications so some notes on this subject are given later.

Dendrites growing outward from the surface of the electrode will eventually penetrate the separator material keeping the two plates apart and cause a short-circuit. The problem is aggravated by the fact that the manufacturers put the two electrodes close together to make the oxygen-diffusion process described in part 3 easier, and also because the separator is deliberately made porous by using an open-wave material for the very same reason. The short circuit formed by a slender Cadmium filament may be of high resistance, but several dendrites will have a cumulative effect and make the problem acute.

Since the dendrites grow during recharging, it is often the case that a cell will reach half-charge when the growing dendrites manage to bridge the inter-plate gap. The cell will then become 'stuck' at half-charge since the dendrites will divert further charging current through themselves. As there are no symptoms at all, the user will remain in

blissful ignorance that this has happened.

When the cell is put into service, it will appear to have very little charge. Of course it had only a partial charge to start with, but on standing even this will leak away through the dendrites. This scenario must be familiar to most users of sealed NiCd cells!

There are many published designs around for chargers for NiCd cells which use d.c., and some even go to the trouble of smoothing the d.c. before applying it to the cells, but using d.c. is probably the *worst possible way* of recharging NiCd cells. Most inexpensive chargers on the market use d.c., although there are one or two which use p.c.r. instead. Note that p.c.r. is a preventive measure, and will not remove dendrites already formed and in place.

DEGRADATION OF THE SEPARATOR

The material used to keep the positive and negative electrodes apart is usually nylon or polypropylene in fibre form. Both these materials are resistant to the highly caustic electrolyte solution and are excellent insulators, and have good mechanical strength initially, but there are two shortcomings. Firstly, nylon and polypropylene have rather low melting-points (220°C and 170°C respectively) and although you may think these temperatures are unlikely in a NiCad cell, during circuit conditions a very high current can flow due to the low internal resistance. This can cause local hot-spots internally. Of course, these plastics soften considerably before reaching the melting point and separator failure may occur at lower temperatures. There is a simple solution – use a fuse.

Secondly, persistent overcharging at the normal rate (C/10 for standard cells) may degrade the separator. Unfortunately it is widely believed that sealed NiCds can be overcharged at this rate indefinitely, and this has been encouraged in the sales literature. In truth, the separator has a limited life, due to the fact that it is attacked by the oxygen that diffuses the electrodes during overcharge, even if this overcharge is within the safe limits. If you keep your NiCds on charge longer than necessary, every time you recharge, then the accumulated effect of oxygen attack on the separator may well lead to premature failure due to an internal short-circuit.

Table 1. *Component values*

Cell size	AA	C	D	F
R7 to R10 (ohms)	82(1)	68(1)	47(2)	33(2)
R11 to R14 (ohms)	8.2(4)	6.8(4)	3.9(7)	2.2(11)

Note: figure in brackets is recommended wattage of resistor.
If charging 'F' or 'SuperF' cells, change diodes D7 to D10 for a 3-amp rated rectifier diode such as 1N5401.

Table 2. *Transformer details*

Transformers	AA & C	12VA	RS 207–627
	D	20VA	RS 207–122
	F	50VA	RS 207–239

The solution to this problem is to stop charging as soon as the overcharge phase sets in. This can be done by detecting the slight rise in temperature during overcharge (3 to 5°C) by using a sensitive differential heat sensor clamped to the body of the NiCd, or by giving a timed recharge. If using the latter method then the cells should be in a near-fully discharged state to begin with. Of these two techniques, the timed-recharge is the simplest and cheapest.

If you look at an old NiCd that has been kept on recharge too long – by being continuously trickle-charged for instance – you will probably find the fibres of nylon forming the separator have degraded to a soft, crumbly state. Oxygen attack is made worse by the fact that the nylon is in a finely-divided state as thin fibre matting, exposing a large surface area to attack. So, if you are in the habit of leaving your NiCads on charge long after they have reached full charge, you must expect premature failure from this cause.

CONSTRUCTING A NICAD CHARGER WITH A TIMED CHARGE

The circuit diagram for the timer-charger is exactly the same as that on page 17 of the July issue of P.E. with the exception that the charging resistors R7 to R14 are of different value and wattage, and the mains transformer must be up-rated to cope with the heavier load. The resistor values are given in Table 1 and the transformer types in Table 2. This charger is for *standard* cells and charges at approximately C/10.

There is an important difference in construction. With dry cell recharging it is best to keep the cells physically apart from the electronics, either by putting the cell holders outside the case, or by putting some distance between the cells and the p.c.b. so that any cells which are faulty and develop a leak do not cause damage to the electronics. With NiCads, the opposite is needed. As we have seen, a reasonably high temperature is needed to ensure that the oxygen-recombination process described in part 3 can take place at a rate that can cope with the evolution of oxygen. The heat generated by the electronics can be used to ensure this, by putting the cells in close proximity to the charge resistors, or at least ensuring that the warm air from the resistors can circulate round the cells to keep them warm. A temperature of 20°C to 30°C is suitable.

With careful attention to case design it is possible to avoid the low-temperature danger zone for NiCads even if the charger is used in an unheated outbuilding like a garage during the middle of winter.

The 11 hour 40 minute recharge time is of course shorter than the familiar 14 hours quoted by the manufacturers for full recharge. However, if you have read part 3 you will no longer be discharging your NiCad batteries fully before recharging, so you will be recharging cells with some charge remaining in them. Also, neither will you be overcharging them, so bearing these two facts in mind, an 11 hour 40 min. recharge time will be very satisfactory.

A modified design of NiCad is now making its appearance which has a slightly higher maximum possible continuous charge, and thus a shorter recharge time of 12 hrs. If you use these cells, you can reduce the resistor values of table 1 slightly on a pro-rata basis to provide a higher recharge current.

SUMMARY OF PARTS 1 to 4

(1) When choosing a battery for a project, don't just choose a NiCad because it is rechargeable. Remember the main snags of the NiCad, particularly that the sintered type discharges itself fairly rapidly on standing, and remember too that dry cells are also rechargeable, and hold their charge better.

(2) Avoid layer batteries like PP3, PP7 etc. – they are by far the most expensive way of powering circuits and cannot be recharged. In particular, avoid the NiCad PP3 equivalent, which has more hidden snags than advantages. If you need 6v or more to power a circuit, look at the cheaper, long-term alternative of Verkon d.c./d.c. converter running from a single cell. The only time a PP3 should be used is when the current drain is less than ½ mA, when a d.c./d.c. converter is not quite so applicable.

(3) For projects that require good duration, choose alkaline-manganese cells (Duracell). NiCads have almost the poorest capacity of the commonly-available batteries when size and weight are taken into consideration.

(4) Do not use d.c. for recharging NiCads or dry cells. Use p.c.r. instead.

(5) Avoid over-discharging NiCads by using Schottky diodes on each cell in a battery.

(6) Avoid persistent over-charging of NiCads by using a timer-charger. Avoid also trickle-charging continuously unless absolutely necessary.

PE

MAKING FREQUENCY FILTERS USING TABLES FOR AF, RF, VHF AND UHF

BY A. B. BRADSHAW

Going by the book

A look at low and high pass filter design using charts and tables. Analogue filters are still an essential part of electronics design despite widespread use of digital circuits. (See PE June 1981)

FREQUENCY filters fall naturally into three requirements – Low Pass, High Pass and Band Pass.

The response curves of practical filters are less than ideal, and are in fact approximations.

These approximations are usually known by their originators names. See Chart 1 showing characteristics of three better known approximations. The Eliptic Function filter gives the best 'Shape Factor', this being a measure of the rectangularity of the response.

Another important feature of this type, is that its passband ripples and Minimum stop band attenuation are Constant and Defined. Hence this is often the modern choice. Generally speaking, the more performance required from any filter, the more carefully if must be made. The component tolerances must be tighter, and the 'Q' values must be accurate. All this is referred to by the phrase 'Component Sensitivity'.

It is because of the Butterworths insensitivity that it is so often specified. To design a frequency filter nowadays, a set of filter tables are indispensable; when these are obtained the design stage is basically an arithmetical operation, with a hand held calculator.

The reader is earnestly urged to get a copy of **Simplified Modern Filter Design** by Phillip R. Geffe, published by Iliffe. The value of this book lies in its appendix, where can be found sixty pages of design tables.

If you cannot obtain a copy of this, the tables of Eliptic Function filters are to be found in **On the design of filters by synthesis I.R.E. Transactions on circuit theory by R. Saal and E. Ullbrich,** published December 1958, see pages 284–328. The local library service should be able to provide a copy of this.

TABLES AND SYMBOLS

See Charts 2 and 3. These show the meaning and relevance to the networks, better performance being obtained from type 2.

The tables are normalised to a terminating resistance of one ohm, and a radian frequency of unity. This gives large values or reactance for 'L' and 'C', but is done to make the tables numerically simpler.

The way the tables are used is by employing scaling factors.

IMPEDANCE SCALING

This removes the 1Ω termination, and adjusts the filter to the new value, this process does not affect the response shape, all attenuations occurring at the same frequencies prior to scaling.

Multiply all impedances by K1 (Impedance scale factor)

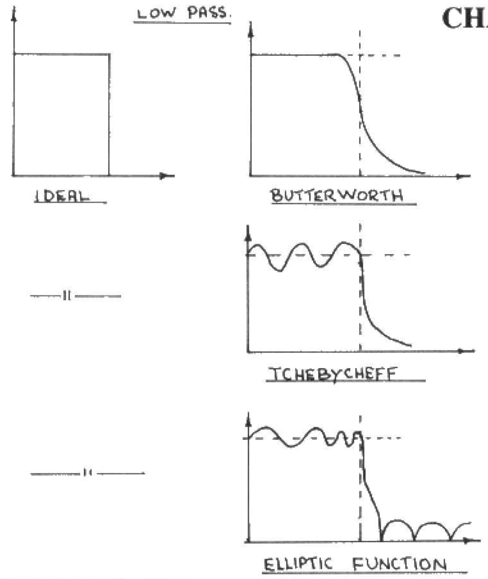
Then $R^1 = K_1 R$

$L^1 = K_1 L$

$C^1 = \frac{C}{K_1}$

(Where the 'primes' indicate the impedance scaled value, the 'L') and 'C' being the values obtained from the tables.

CHART 1



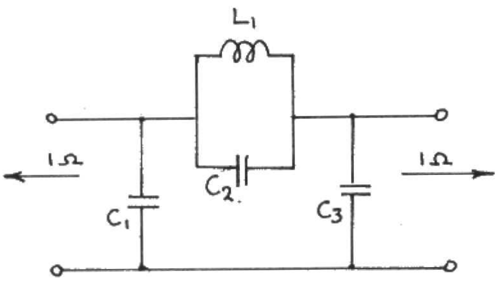
MAIN PROPERTIES

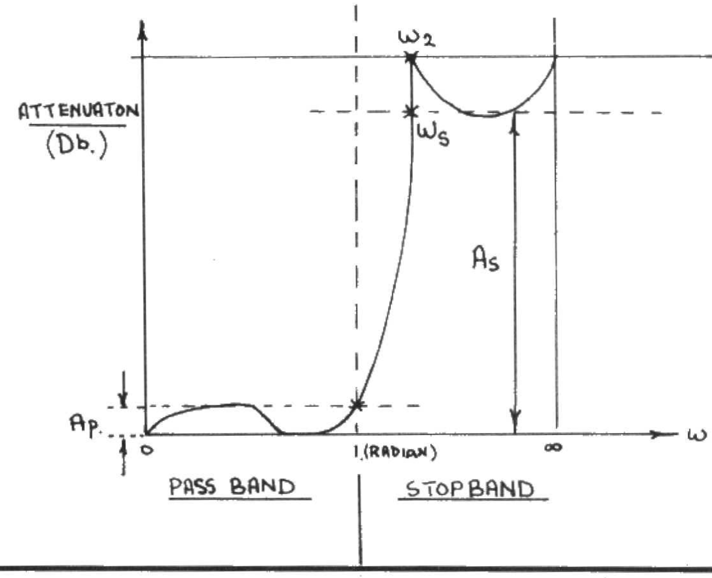
Very flat pass band. Attenuation continues to increase in the stop band.
Simple to set up.
Very poor pass/stop band transition.

Equally spaced ripples in bass band.
Attenuation continues to increase in the stop band.
More difficult to set up than Butterworth.
Good pass/stop band transition.

Unequally spaced ripples in pass band.
Attenuation is defined in stop band.
Ripples in stop band.
More difficult than Butterworth to set up.
Very good pass/stop band transition.

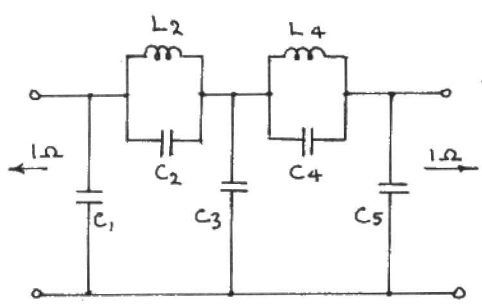
CHART 2 **LOW PASS ELLIPTIC FUNCTIONS**

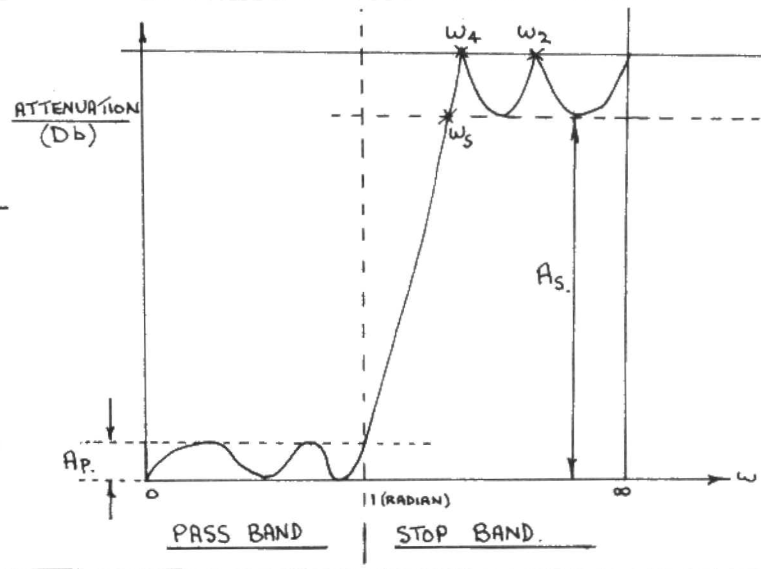




A_p = amplitude of pass band ripples (Db)
A_s = minimum stop band attenuation (Db)
W_s = frequency at which A_s occurs
W_2 = frequency of infinite attenuation

CHART 3 **LOW PASS ELLIPTIC FUNCTION – TABLE A4–4**





A_p = amplitude of pass band ripples (Db)
A_s = minimum stop band attenuation (Db)
W_s = frequency at which A_s occurs
W_4 = 1st frequency of infinite attenuation
W_2 = 2nd frequency of infinite attenuation

FREQUENCY SCALING

This leaves all impedances the same, but translates the response shape to the frequency range we require.

Divide all reactive components by K2 (Frequency scale factor)

$$L^1 = \frac{L}{K_2}$$

$$C^1 = \frac{C}{K_2}$$

All the numbers on the frequency scale are now multiplied by K_2.

In practice this impedance/frequency scaling procedure is performed in one operation.

Hence

$$L^1 = \frac{\text{(Req'd impedance) x (one radian) x (value of 'L' from tables}}{\text{(one ohm) x (}2\pi\text{ new frequency)}}$$

$$\text{ie, } L^1 = \frac{RL}{2\pi f}$$

and

$$C^1 = \frac{\text{(one ohm) x (one radian) x (value of 'C' from tables}}{\text{(Req'd impedance) x (}2\pi\text{ new frequency)}}$$

$$\text{ie, } C^1 = \frac{C}{2\pi fR}$$

Note f = *pass band edge*

So from this

$\frac{R}{2\pi f}$ is decided by the designer and is calculated as a number (A)

$\frac{1}{2\pi fR}$ is decided by the designer and is calculated as a number (B)

giving us

$$L^1 = AL.$$

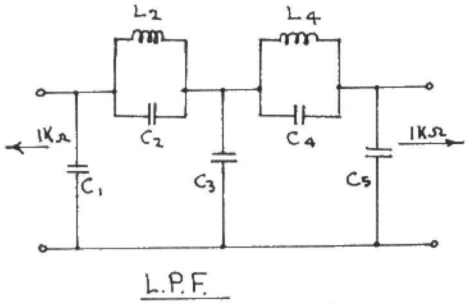
$$C^1 = BC.$$

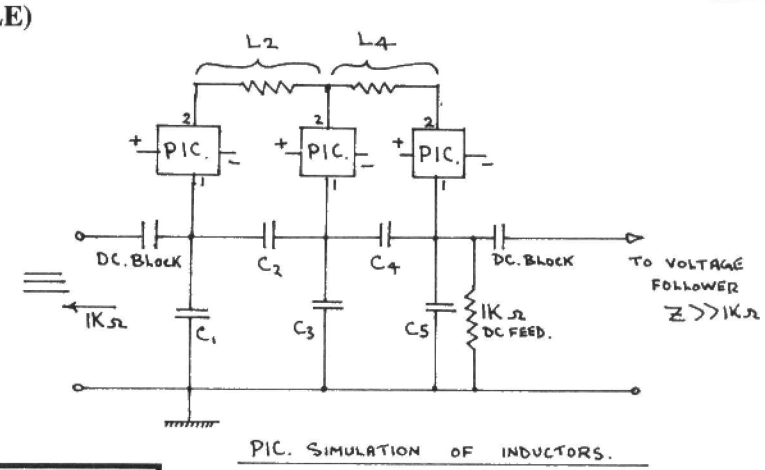
This brings us back into the world of millihenries and microfarads.

We have set the band edge, and the impedance, by the aforesaid scaling.

CHART 4 (WORKED EXAMPLE)

L.P.F.





In certain circumstances, PIC's may be used as an alternative to inductors. For more information – See June 1981 PE.

1 Db pass band ripple
5 kHz pass band edge
6·085 kHz stop band edge
40 Db stop band attenuation (minimum)
C_1 = 59240 pf
C_2 = 11830 pf
C_3 = 68110 pf
C_4 = 35200 pf
C_5 = 45380 pf
L_2 = 27·76 millihenries
L_4 = 18·38 millihenries

We now have to decide the *minimum* stop band attenuation, and the frequency at this this occurs.

At this point we must have access to the design tables.

WORKED EXAMPLE – L.P.F.

Choosing an impedance of 1K, and a passband edge of 5Khz, a filter may be constructed for say, cleaning up the audio output of a medium wave broadcast receiver.

In this case $A = \frac{R}{2\pi f.} = \frac{10^3}{2\pi 10^7} = 31.8$ (millihenries multiplier)

$B = \frac{1}{2\pi f.} = \frac{1}{2\pi 10^7} = 0.03183$ (microfads multiplier)

On reading the tables, we can obtain a stopband attenuation of 40 Db at 6.085khz, with a 1 Db passband ripple, if we use the constants for 'C' and 'L' as below.

C_1 = 1.861		59240 PF.
C_2 = 0.372	Multiply by	11830 PF.
C_3 = 2.142	B = 0.03183	68115 PF.
C_4 = 1.107		35200 PF.
C_5 = 1.427		45378 PF.
L_2 = 0.873	Multiply by	27.7614 Millihenries
L_4 = 0.578	A = 31.8	18.380 Millihenries

W_s = 1.217
A_s = 40Db

See Chart 4.

HIGH PASS FILTERS

These are derived from the low pass, by a network transformation.

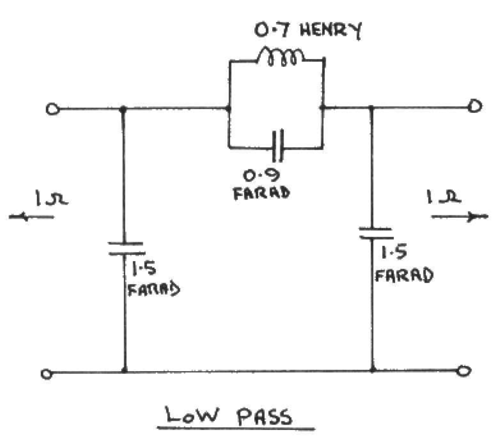
To transform the low pass network to a high pass, each coil becomes a capacitor and each capacitor becomes a coil. The element values are also inverted, see Chart 5. The low pass response shapes are 'rotated' about W = 1, the attenuations remaining the same, but now occur at the reciprocals of the previous frequencies.

This sounds complicated, but Chart 6 makes it clear. Before proceeding to a worked example on HP filters, one further point is considered. The network in Chart 5 contains 3 inductors to realise the HP response, but there is a more economic way.

DUALS

This has nothing to do with weapons!, but any ladder network has its dual, the two networks have the same respone.

CHART 5 A TYPICAL LP TO HP TRANSFORMATION



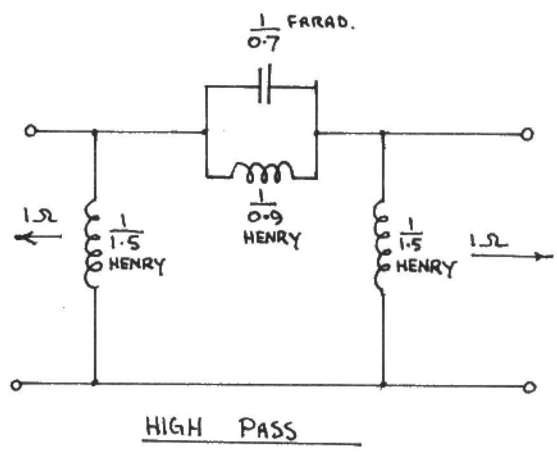
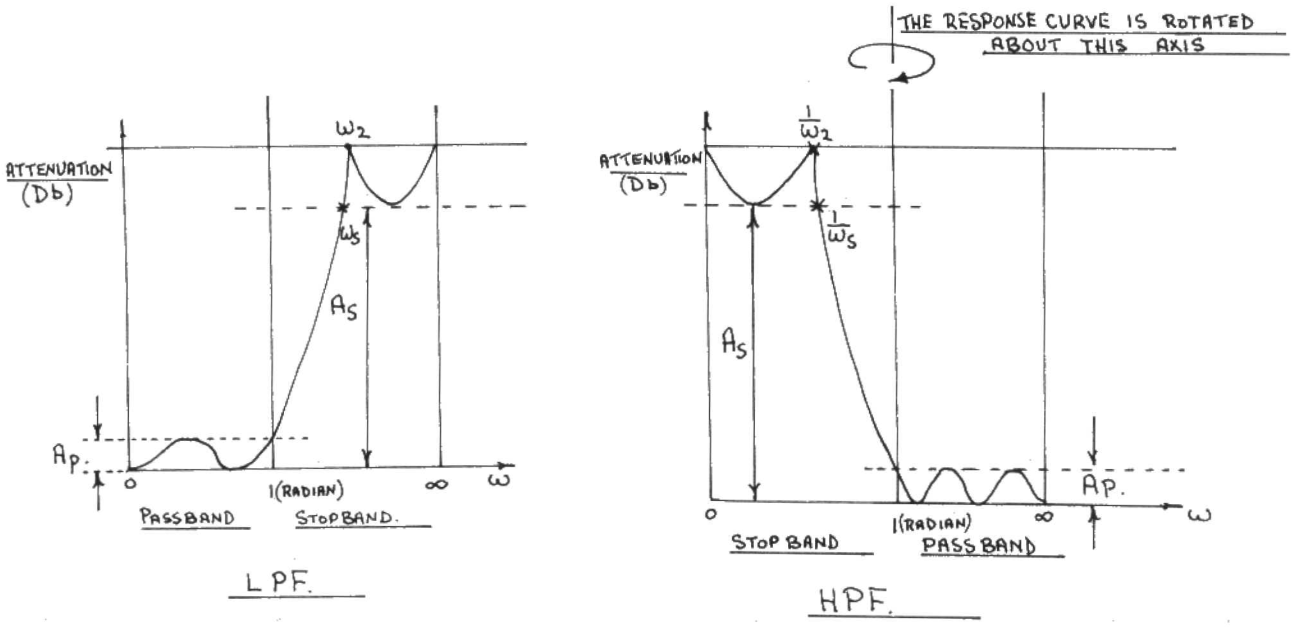


CHART 6 (SEE CHART 2 FOR MEANING OF SYMBOLS)



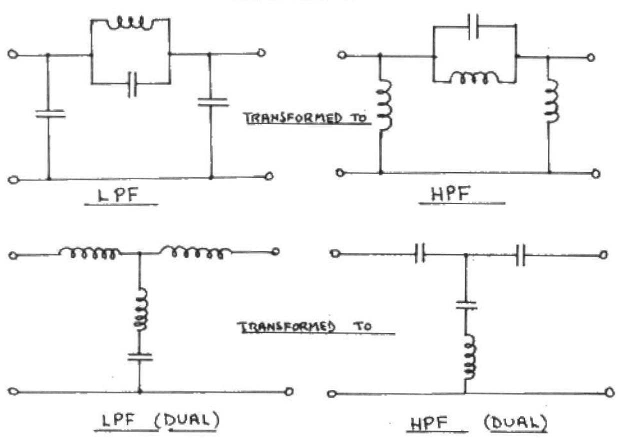
It is always worth looking at the dual, to see if we can (in our case) reduce the number of inductors.

An example on duals and LP to HP transforms is shown on Chart 7.

Using this approach for HP filters, PIC simulation is very convenient. This method is described in PE 1981.

The filter design tables also show the values for the dual networks.

CHART 7



WORKED EXAMPLE – H.P.F.

A filter is required to attenuate the lower frequencies in an intercom system, the lower AF range is used for tone signalling. The frequencies above 300 hz are for speech. The filter impedance is to be 2K, the stop band minimum, 50 Db. Passband ripple again 1 Db.

We look up the tables, and find the following data for the *LPF dual.*

A_s = 50Db — From Table A4-4
W_s = 1.407
L_1 = 1.933 — Ap = 1 Db
L_2 = 0.223
C_2 = 0.963
L_3 = 2.392
L_4 = 0.626
C_4 = 0.750
L_5 = 1.635

Scaled HFP dual

$$C_1 = \frac{1}{1.933} = 0.5173 \times 0.26252 = 0.1358\ \mu F$$

$$C_2 = \frac{1}{0.223} = 4.4843 \times 0.26252 = 1.1772\ \mu F$$

$$C_3 = \frac{1}{2.392} = 0.4181 \times 0.26252 = 0.1098\ \mu F$$

$$C_4 = \frac{1}{0.626} = 1.5974 \times 0.26252 = 0.4193\ \mu F$$

$$C_5 = \frac{1}{1.635} = 0.6116 \times 0.26252 = 0.1606\ \mu F$$

$$L_2 = \frac{1}{0.963} = 1.0384 \times 1.061 = 1.1017 \text{ henry}$$

$$L_4 = \frac{1}{0.750} = 1.3333 \times 1.061 = 1.4146 \text{ henry.}$$

With a passband edge at 300 hz, the stop band of 50 Db will be at,

$$\frac{300}{1.407} = 213 \text{ hz}$$

Hence 0-200 hz containing signalling tones are 50 Db lower than the speech band.

The LP dual is now transformed to the HP dual, with inverted values. See Chart 8.

The impedance and frequency scaling is now performed on the Hp dual.

$$A = \frac{2x10^3}{2\pi.300} = 1.061 \text{ (henries multiplier)}$$

$$B = \frac{1}{2\pi 300.2x10^3} = 0.262525 \text{ (microfads multiplier)}$$

For those readers with further interest in filter design, photocopies of the June 1981 PE article entitled Positive Impedance Convertors (PIC's) is available from our editorial office – Price 75p

A SINGLE BOARD COMPUTER USING THE HD6301V

PART TWO BY NICK HAMPSHIRE

Software considerations in constructing the MD6301V SBC

IN last month's issue we looked at the design of a single board computer circuit based on the Hitachi HD6301V single chip computer. The design gave a fully expanded system, but part of the rationale for using this chip is that the HD6301V can be used in a range of different configurations right down to a one chip system. This flexibility means that it is unnecessary in many applications to utilise the whole circuit. However, what is important is that before constructing the circuit, either the full implementation or a cut down version, the software design is thoroughly understood.

A knowledge of the memory allocation, software design and system programming must be understood before starting to construct the system. This is because some software must be resident in the system before it will work, and this necessitates the programming of the EPROM memory on the processor chip.

When the processor is switched on it will automatically go into 'reset' mode and look for a 'reset vector' address stored at the top of memory. This 'reset vector' address points to the starting location in memory of a program. If no 'reset vector' address exists or no programme exists then the processor will crash. It is thus essential that the correct 'vectors' are stored in the EPROM at the top of memory and that a program starts at the address pointed to by the 'reset vector'.

Besides the 'reset vector' the HD6301V has eight other vector addresses stored at the top of memory. These addresses tell the processor where code is located to perform a range of different interrupt operations. The vector table is shown in Fig. 4. All these other eight vectors should be given valid addresses when programming the on processor EPROM.

If the programmes to be run by the system are to reside in RAM it is not unlikely that they will have variable starting addresses and they will almost certainly have different locations for their interrupt handling routines. The technique used to solve this problem is called RAM vectoring. This requires that all the vector addresses, with the

Fig. 4. *Interrupt vector memory map*

	Vector		Interrupt
	MSO	LSO	
Highest Priority	FFFE	FFFF	$\overline{\text{RES}}$
	FFEE	FFEF	TRAP
	FFFC	FFFD	$\overline{\text{NMI}}$
	FFFA	FFFB	Software Interrupt (SWI)
	FFF8	FFF9	$\overline{\text{IRQ}_1}$ (or $\overline{\text{IS3}}$)
	FFF6	FFF7	ICF (Timer Input Capture)
	FFF4	FFF5	OCF (Timer Output Compare)
	FFF2	FFF3	TOF (Timer Overflow)
Lowest Priority	FFF0	FFF1	SCI (RDRF + ORFE + TDRE)

exception of the 'reset vector' located at the top of memory point to RAM locations. These RAM locations are then set up by the initialisation programme to contain the actual vector addresses each stored in three successive bytes. The first byte contains a Jump command and the following two bytes contain the address.

Whether the vector addresses are stored in EPROM or RAM they will require the addition of some sort of system initialisation programme. This program will be run on 'reset' and will set up variable locations, initialise I/O port registers (all on chip I/O port registers are located at the bottom of memory and are shown in Fig. 6), and if required put the system into loop to request input from a terminal device. This input could be another program or simply a command to initiate a particular routine already stored in the system's memory.

USING THE SERIAL PORT

The HD6301V is equipped with on chip serial input and output lines. Suitably buffered and driven these lines can be used to connect the chip to any serial terminal. The serial communications hardware is controlled by four registers as shown in Fig. 5. The 'Transmit Data Register' in memory location \$0013 is a single byte into which any data byte to be transmitted is first placed. The hardware will shift the contents of this byte out bit by bit as a ten bit signal, one start bit, eight data bits and one stop bit.

The 'Receive Data Register' is at location \$0012. A ten bit serial signal received on the input line will be decoded and stored as an eight bit byte in this location where it may be read by the serial communications software. The speed at which data is transmitted or received and the format in which it is transmitted are set by the 'Rate and

Fig. 5. *Control hardware*

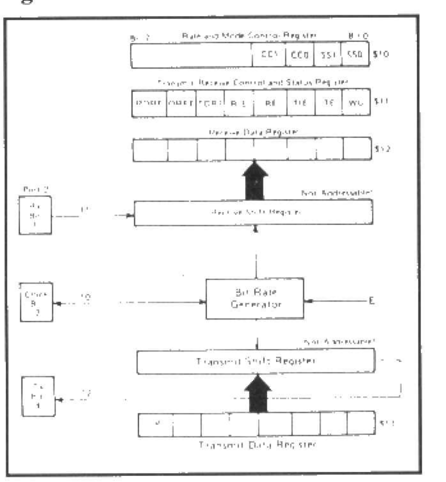


Fig. 6. *Internal Register Area*

Register	Address
Port 1 Data Direction Register****	00*
Port 2 Data Direction Register****	01
Port 1 Data Register	02*
Port 2 Data Register	03
Port 3 Data Direction Register****	04**
Port 4 Data Direction Register****	05***
Port 3 Data Register	06**
Port 4 Data Register	07***
Timer Control and Status Register	08
Counter (High Byte)	09
Counter (Low Byte)	0A
Output Compare Register (High Byte)	0B
Output Compare Register (Low Byte)	0C
Input Capture Register (High Byte)	0D
Input Capture Register (Low Byte)	0E
Port 3 Control and Status Register	0F**
Rate and Mode Control Register	10
Transmit/Receive Control and Status Register	11
Receive Data Register	12
Transmit Data Register	13
RAM Control Register	14
Reserved	15-1F

* External address in Mode 1
** External address in modes 0, 1, 2, 4, 6; cannot be accessed in Mode 5
*** External address in Modes 0, 1, 2, 4
**** 1 = Output, 0 = Input

Mode Control Register' in location $0010, the control functions initiated by this register are shown in Fig. 7.

The most complex of all the registers is the 'Transmit/Receive Control Status Register' at location $0011. This register controls the actual operation of the serial communications port, each of the eight bits having a different function, they are as follows:

Bit 0—WU Wake-up flag, this can be software set but is cleared on receipt of ten consecutive '1' bits on the receive line. This is used to signal to the processor that a message is being received.

Bit 1—TE Transmit Enable, when set produces an initial preamble of ten consecutive '1' bits, it also sets all the internal hardware to allow serial data to be transmitted on line 4 of port 2, when TE is clear this line can be used as a normal I/O port line.

Bit 2—TIE Transmit Interrupt Enable, when this bit is set and bit 5 is also set it will generate an IRQ interrupt, when clear the TDRE interrupt is masked.

Bit 3—RE Receive Enable, when set allows line 3 of port 2 to be used as the serial input line, when clear it can be used as a normal I/O port line.

Bit 4—RIE Receive Interrupt Enable, when this bit is set and bit 6 or bit 7 are also set it will generate an IRQ, when clear IRQ interrupt is masked.

Bit 5—TDRE Transmit Data Register Empty, this flag can only be read and indicates that a complete byte of data has been transmitted. It is cleared by first reading the status register and then writing a new data byte into the transmit data register.

Bit 6—ORFE Over Run Framing Error, this error flag is set by the hardware when an attempt is made to put new data into the received data register when it still contains the previous byte received and the RDRF flag is still set. This flag is cleared by reading the status register and then reading the received data register.

Bit 7—RDRF Received Data Register Full, this flag is set when a complete byte of data has been received, it is cleared by first reading the status register and then reading the received data register.

Programming the serial port is not complex. On power-up or reset the serial I/O hardware should be initialised. Initialisation is simply a matter of writing the desired operation control bits into the rate and mode control register and then writing the desired bits into the TRCS register in order to initiate serial communications operation. When using the serial lines it is simply a matter of reading data from or writing data to the correct register in response to interrupts generated by a byte of data received or the completion of transmission of a byte. The wake-up feature can be used to flag the presence of incoming data.

WRITING SOFTWARE FOR THE HD6301V

The HD6301V uses an enhanced version of the Motorolla 6800 microprocessor instruction set and anyone familiar with programming either the 6800, 6809 or 6502 should have little difficulty understanding the instruction set. There are two methods of approaching the writing of software for this device, hand coding and using a cross assembler. Hand coding is fine for short programmes or longer programmes which can easily be split into separate small subroutines, however, for routines longer than about 200 or 300 bytes the calculation of jumps and branches can get too cumbersome. A far easier approach is to use a cross assembler, this is an assembler programme written on another computer which will assemble code for the target processor. Such a cross assembler is available for the HD6301V and runs on a standard BBC micro and is produced by Crossware Products.

(They can be contacted at 2 The Lawns, Melbourn, Royston, Herts SG8 6BA. Telephone 0763 61539).

The cross assembler functions like any ordinary assembler and the code can be written using labels rather than having to calculate branches and jumps. The cross assembler will produce a data file which can be fed into the EPROM programmer unit for programming the HD6301V.

Fig. 7. *Transfer rate/mode control register*

7	6	5	4	3	2	1	0	
X	X	X	X	CC1	CC0	SS1	SS0	ADDR: $0010

SCI Bit Times and Transfer Rates

		XTAL	2·4576MHz	4·0MHz	4·9152MHz
SS1	SS0	E	614·4kHz	1·0MHz	1·2288MHz
0	0	E ÷ 16	26μs/38,400 Baud	16μs/62,500 Baud	13μs 76,800 Baud
0	1	E ÷ 128	208μs/4,800 Baud	128μs/7812·5 Baud	104·2μs 9,600 Baud
1	0	E ÷ 1024	1·67ms/600 Baud	1·024ms/976·6 Baud	833·3μs 1,200 Baud
1	1	E ÷ 4096	6·67ms/150 Baud	4·096ms/244·1 Baud	3·333ms 300 Baud

SCI Format and Clock Source Control

CC1, CC0	Format	Clock Source	Port 2 Bit 2	Port 2 Bit 3	Port 2 Bit 4
00	—	—	—		—
01	NRZ	Internal	Not Used	**	**
10	NRZ	Internal	Output*	**	**
11	NRZ	External	Input	**	**

* Clock output is available regardless of values for bits RE and TE.
** Bit 3 is used for serial input if RE = '1' in TRCS.
Bit 4 is used for serial output if TE = '1' in TRCS.

READERS LETTERS

Dear Sir,

The use of a recognised standard bus in PE computer projects is welcome, as home processor projects are often plagued by incompatibility. But compatiblity can only be maintained if people stick to the standards. Nick Hampshire's SBC-1 is an excellent single-board computer (with a very good choice of processor) but it is simply not STE, for the following reasons:

(1) Most crucially, STE is asynchronous. That is, when the processor addresses another board, it must wait until the board has accepted the data (on write) or has data ready (read). The DATACK line indicates this, and this can be asserted anything from a few nanoseconds after the valid address, to several microseconds, depending on the addressed board's speed. The 6301 is purely synchronous.

(2) The CMO, 1 and 2 lines indicate the cycle type (memory read/write, I/O read/write and others) and will not work properly when connected to a port as shown. They are part of the address system, and must operate at the same speed as the address lines. Also, the DATSTB line should be low when (and only when) these are valid.

(3) The STE clock is 16MHz +/−0.25MHz, not 1MHz. Many peripherals use this clock directly, and will not work properly at the lower frequency.

(4) Finally, the STE bus must be buffered close to the edge connector. It achieves its high performance by careful timings derived using transmission line techniques. The backplane impedance will be upset by long on-board connections.

The change required to make the SBC-1 truly STE compatible include an external clock circuit, derived from 16MHz, with a clock stretcher controlled by DATACK, and a separate clock for the serial port; handshake logic; and bus buffers.

But why do this, when the SBC-1 is already almost compatible with another widely-used 8-bit bus, the G64 bus?This is a much simpler 8 bit Eurocard bus, with only 64K memory range, but there are only 8K and a bit spare anyway. This bus is very common in industrial use, and is quite well supported.

I hope this will help to prevent readers getting a false impression of the STE bus, and help to prevent compatibility problems in the future.

Paul Burke

Dear Sir,

I would like to say that I regard Practical Electronics as one of the better British electronic magazines that I read and I am amazed that IPC sold it. I hope it was not due to faling sales, something I find hard to imagine.

I presume your survey (attached, a little late – sorry) is to inform you on how best to increase/maintain sales volumes. At the risk of sounding pedantic shouldn't we rather look at how the electronics magazine came into being as a way of the keen d.i.y. man to build his own cat's whisker radio etc. At the moment I rate PE highly because it contains articles of practical (pardon the pun) use, unlike some of your rival publications who tend to go a bit over the top. (Example: A publication who in 1985 published a five or six part article on how to store a TV frame, it was horrendously complicated and, in my view, of limited appeal to even the most advanced constructor.) I think the purpose of electronics magazines is to be in advance of even the consumer electronics industry but not too far!

I think your article mix at the moment is quite satisfactory but improvements could be made.

A Reader

Dear Sir,

Re: STEbus Series

I am writing as Chairman of the STE Manufacturers and Users Group to congratulate your journal on the interest you have shown in STE (1EEEP1000) to the extent of running a series intended to introduce your readers to design of STEbus based cards. However, we at STEMUG would like also to express our concern that the circuit you have published does not conform to the current specification, a copy of which I have sent you under separate cover. The main points of non-compliance are:

Bus clock at incorrect frequency; Bus is not buffered; the board appears to ignore DATACK* and so ignores slave timing.

We at STEMUG would be very pleased to assist you in any way that we can, and should you have any questions concerning STE or the Manufacturers and Users Group, do not hesitate to contract either myself or any of the manufacturers.

Bob Squirrell

Dear Sir,

I was particularly interested in your July issue of P.E. with articles on different aspects of robotics.

I have enquired locally but without success about the existence of amateur groups interested in robots.

Do you know of any national amateur groups that cater for people interested in robot construction or programming? If so perhaps you would publish details in your magazine.

L.H. Bramley

Replies to 'PE Robots'

FREE TO ENTER STE COMPETITION SPONSORED BY DEAN MICROSYSTEMS AND PRACTICAL ELECTRONICS

Win over £400 worth of STE equipment

Practical Electronics has got together with Dean Microsystems, Arcom and the STE Manufacturers And Users Group to offer this great prize. In addition to the above prize, if a suitable entry is received, the winning design might be manufactured and/or marketed on behalf of the author.

WHAT TO DO

All you have to do is send in a 'paper design' for an STE I/O card. Entries will be judged on the basis of originality in concept and application, relevance to the STE market, circuit implementation and manufacturability. Obviously entries which are accompanied by a working prototype will be judged more favourably but it must be stressed that this is not essential.

THE JUDGES

A panel of judges will be set up by the STE Manufacturers and Users Group. Their decision will be final.

RULES AND CONDITIONS

1) All entries must reach our editorial offices by Dec 31st 1986.
2) Entries must be the original work of the author/designer.
3) Entries must not have been offered for manufacture or publication previously.
4) Entries cannot be returned unless accompanied by a large stamped addressed envelope.
5) Practical Electronics will automatically gain first publishing rights on all entries received.
6) The judges decision, in consultation with Practical Electronics, will be final.

THE PRIZES

The winner will receive a ten-slot STE backplane and line termination networks donated by **Dean Microsystems** *plus a Z80 CPU card donated by* **Arcom** *plus £150 STE voucher donated by Practical Electronics.*

R9. This has the effect of improving the high frequency response of the device as well as improving its sensitivity. The pulses of light from the fibre optic cable have the effect of increasing the leakage current of TR3 and generating small negative pulses at its collector terminal. These are amplified by TR4 which is a high gain common emitter amplifier. IC2 operates as a comparator/trigger circuit with positive feedback via C6 to improve the output waveform. It is not essential for the phase locked loop (a 4046BE type) to be fed with a clipped input signal, but in critical applications such as the current one this seems to give better results. IC2 also effectively provides some extra voltage gain which reduces the risk of the input signal being inadequate to drive the unit properly.

IC3 is the phase locked loop, and this operates in the standard 4046BE configuration. C8 and R17 are the VCO timing components, and R19 plus C9 form the lowpass filter. R18 is the load resistor for the internal source follower buffer stage which provides the demodulated output signal. The 4046BE has two phase comparators, one of which is the conventional type which causes the VCO to assume its centre frequency in the absence of an input signal. The other sweeps the VCO down to zero operating frequency in the absence of an input signal, effectively switching it off. It is this second phase comparator which is used in this case, and its wider lock range provides better performance in most applications.

The buffered output of IC3 is smoothed by a passive third order lowpass filter. This has its cut-off frequency set slightly higher than the maximum input frequency, and the circuit was designed with a maximum baud rate of 9600 in mind (which corresponds to a maximum signal frequency of 4·8kHz). However, the filter provides little attenuation at 9·6kHz, and as explained previously, the system will work properly at 19200 baud. IC4 is the trigger circuit and VR1 is adjusted to give a properly decoded output waveform. IC4 is powered from dual supplies of plus 9 to 10 volts and minus 12 volts, which results in output levels of approximately plus and minus 9 volts. This is less than the nominal RS232C plus and minus 12 volt levels, but is obviously much more than the minimum requirement of plus and minus 3 volts.

POWER SUPPLIES

It would be possible to power both units from batteries, but with the transmitter having a fairly high current consumption and the receiver requiring dual supplies it is more practical to use mains power supplies unless porta-

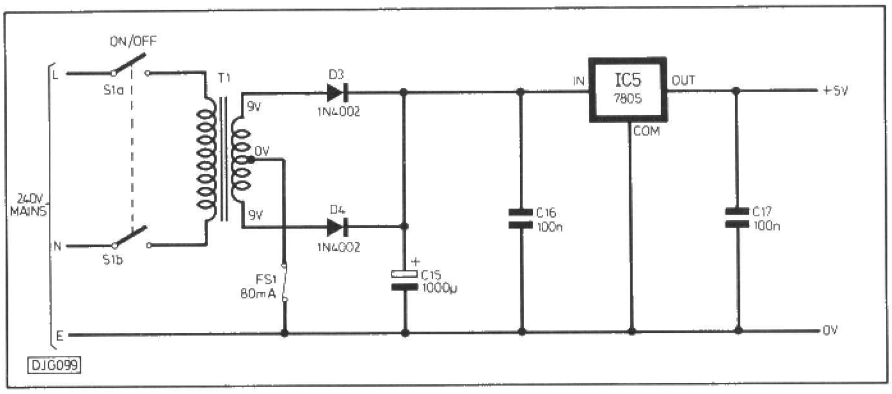


Fig. 5. *Transmitter circuit diagram*

ble operation is required for some reason. Suitable power supply circuits for the transmitter and receiver units are shown in Figs. 5 and 6 respectively.

The transmitter power supply has to provide a well smoothed and regulated 5 volt supply at a current drain of about 50 milliamps. This is provided from mains transformer T1 by a push-pull rectifier and smoothing circuit followed by monolithic voltage regulator IC4. The latter is a standard 1A type rather than a low power (78L05) device since there could be problems with overheating if a 78L05 were to be used. The receiver power supply has two push-pull rectifier and smoothing circuits; one to provide the positive supply and the other to provide the negative supply. IC5 is an adjustable voltage regulator with R25 and R26 setting the positive output voltage between 9 and 10 volts. IC6 stabilises the negative supply at 12 volts. The consumption from both outputs is only a few milliamps, incidentally.

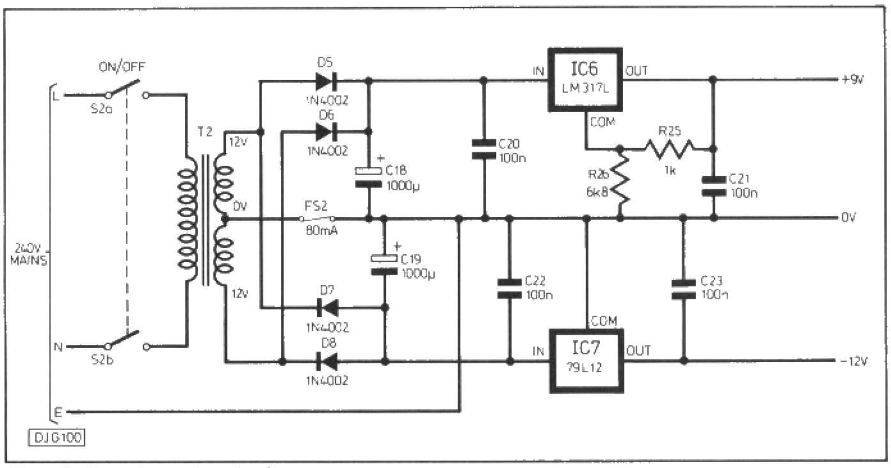


Fig. 6. *Receiver circuit diagram*

CONSTRUCTION

Fig. 7 gives details of the printed circuit board for the transmitter. The 4046BE is a CMOS device and should be fitted in a (16-pin d.i.l.) integrated circuit holder, and the other standard antistatic handling precautions should be taken. FS1 is mounted on the board in a pair of printed circuit mounting fuseclips, but T1 is a chassis mounting type fitted off-board. IC4 does not require a heatsink, and it can simply be mounted horizontally and bolted to the board.

Construction is complicated somewhat by the need to make an optical connection between the l.e.d. and the fibre optic cable, and ideally this link should be one that enables the two to be easily disconnected and reconnected. Connectors can be improvised from grommets and heat-shrink sleeving, as in the audio fibre optic link. There is now an alternative to this as proper fibre optic connectors are available, and the use of these connectors is strongly recommended. They can be used with any standard fibre optic cable having a 2·2 millimetre overall diameter and a 1 millimetre diameter core. Some fibre optic cables do not work well at infra-red wavelength, but as in this case a visible red light source is used, good results should be obtained with any cable intended for communications purposes.

In order to fit the plug onto the end of the cable about 20 millimetres of the outer sleeving must be removed. This must be done carefully or the fibre optic core could be damaged, seriously reducing the light transmission efficiency of the cable. The easiest way of removing the sleeving seems to be to make two 20 millimetre long cuts at the end of it and on opposite sides of the cable. The end of the sleeving can

then be peeled open so that the unwanted pieces can be easily trimmed off without damaging the core. In order to avoid damaging the core (or yourself) when making the slits it is still necessary to exercise a reasonable amount of care, and it might take two or three attempts to get it right. It is worthwhile spending a little time to get things just right though, since rushing things could drastically degrade the performance of the system. Ordinary wire strippers might remove the sleeving without damaging the inner core, but I did not get this method to work at all well. Treat the cable with due respect, and bear in mind that tight bends in the cable can damage it. Most types can take a minimum radius of about 15 to 20 millimetres.

The prepared end of the cable is simply pushed into the rear end of the plug as far as it will go. This should result in a small piece of filament protruding from the front end of the plug. This is trimmed off with a sharp modelling knife, trying to cut through the fibre cleanly in one quick cut at a reasonably accurate right angle. Provided a clean cut is made it is unlikely that any filing or polishing of the filament's end will significantly improve the degree of light transmission.

There is provision for horizontal and vertical mounting of the socket, and in this case it is fitted to the board horizontally. Two small 8BA fixing screws and matching nuts are required. The leadout wires of D2 are carefully bent at right angles so that the body of the component fits into the cavity at the rear of the socket.

The printed circuit board is mounted on the extreme left-hand side of the case, and a cut-out to accommodate the opto connector must be made in the front panel at the appropriate point. This cut-out must be slightly over-size or it will be impossible to fit the board into place. On the prototype a 10 millimetre diameter hole is used here. The board is mounted on the base panel of the case using 6BA fixings including spacers to raise the board by about 6 to 10 millimetres. It is positioned so that the jaws of the opto connector protrude through the front panel. The input socket is mounted to the right and above the opto connector, and although a 3·5 millimetre jack is used on the prototype, any preferred type that will physically fit into the slightly restricted available space can be used. T1 is mounted on the vacant area of the base panel to the right of the component panel, and S1 is mounted on the right-hand section of the front panel. A soldertag on one of T1's mounting bolts provides a chassis connection point for the mains earth lead. For safety reasons it is essential that the case should be earthed, and it must also be a type that has a screw fixing lid so that easy access to the dangerous mains wiring is not possible. It is a good idea to insulate any exposed mains wiring.

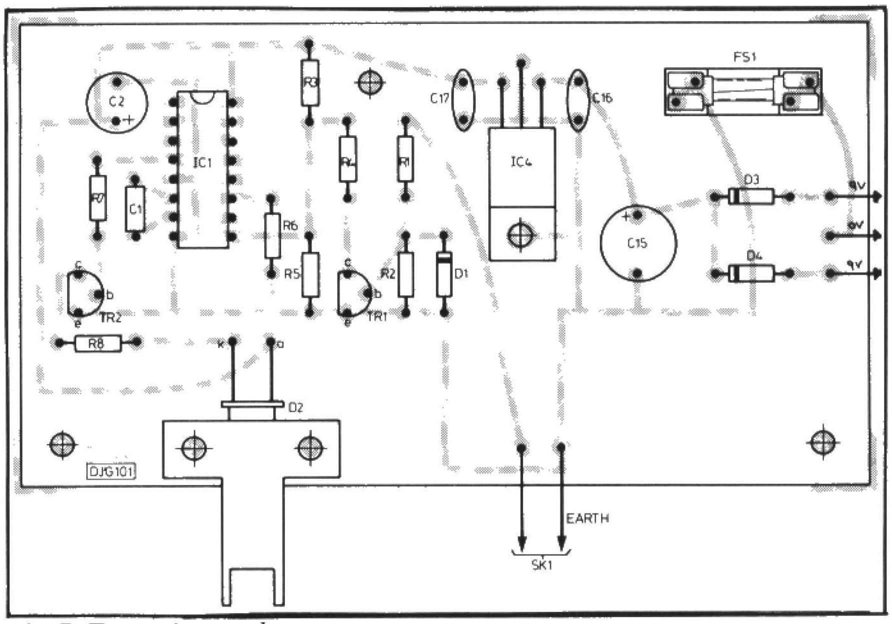


Fig. 7. *Transmitter p.c.b.*

Construction of the receiver will not be described in detail as it follows exactly the same lines as that of the transmitter. Details of the receiver printed circuit board are shown in Fig. 8. The layout of the receiver components is quite critical, and in particular stray feedback from the phase locked loop or the output to the base lead of the photocell must be avoided. Use of the printed circuit layout provided here is therefore strongly advised.

ADJUSTMENT

Setting up is quite easy as there is only one component to adjust (VR1 in the receiver). With suitable test equipment this can be adjusted to give the correct output waveform with a suitable pulse signal applied to the input of the transmitter. It can be trimmed

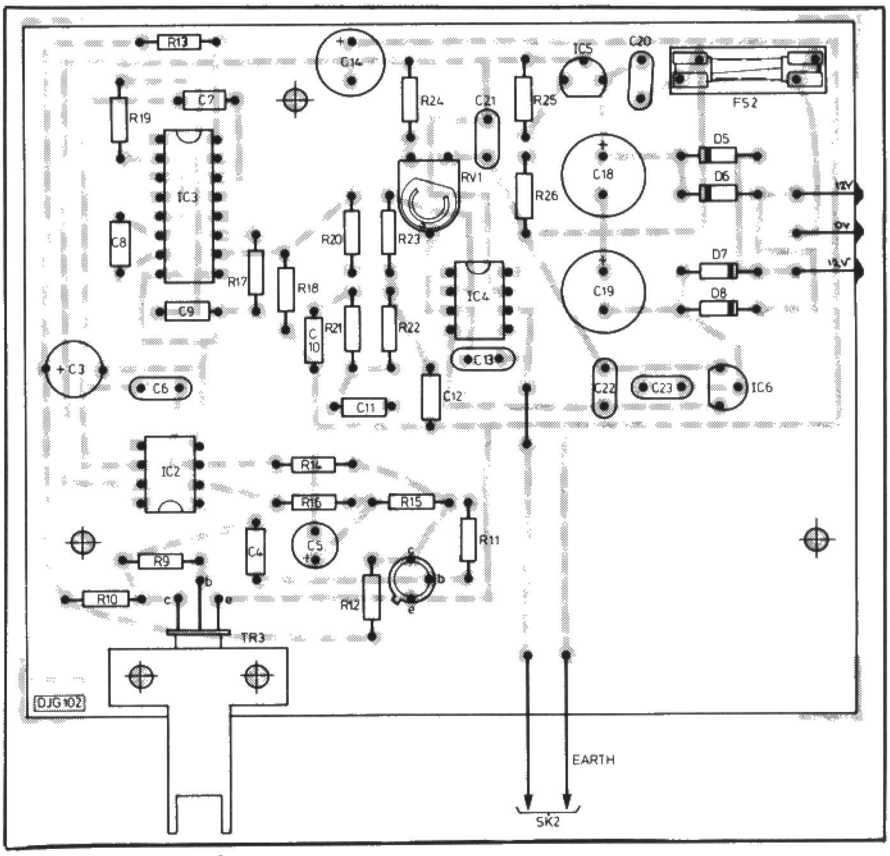


Fig. 8. *Receiver p.c.b.*

COMPONENTS . . .

TRANSMITTER

RESISTORS

R1,R2	3k3 (2 off)
R3,R5,R6	10k (3 off)
R4	33k
R8	33

All resistors 0·25W 5% carbon

CAPACITORS

C1	1n poly layer
C2	220µ 10V radial elect
C15	1000µ 16V radial elect
C16,C17	100n ceramic (2 off)

SEMICONDUCTORS

IC1	4046BE
IC5	7805 (+5V 1A regulator)
TR1	BC547
TR2	BC337
D1	1N4148
D2	Superbright 5mm l.e.d.
D3,D4	1N4002 (2 off)

MISCELLANEOUS

SK1 3·5mm jack socket; T1 mains primary, 9–0–9 volt 75mA secondary; FS1 80mA antisurge, 20mm; S1 rotary main switch; instrument case about 152 × 114 × 44mm; printed circuit board PE118; fibre optic cable, two fibre optic plugs, and one fibre optic socket; 20m p.c.b. fuse clips (2 off); control knob; 16-pin d.i.c. i.c. holder; wire, solder, fixings, etc.

RECEIVER

RESISTORS

R9	4M7
R10	4k7
R11	1M
R12	2k7
R13,R25	1k (2 off)
R14,R16–R19,R23	10k (6 off)
R15	100k
R20–R22	5k6 (3 off)
R24	15k
R26	6k8

All resistors 0·25W 5% carbon

POTENTIOMETER

VR1	10k sub-min hor preset

CAPACITORS

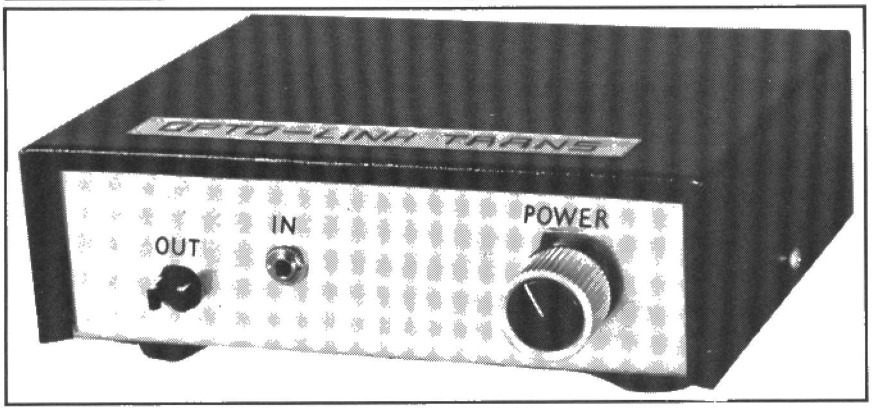
C3,C14	100µ 16V radial elect (2 off)
C4	22n poly layer
C5	2µ2 63V radial elect
C6	47p ceramic plate
C7	100n poly layer
C8,C9,C12	1n poly layer (3 off)
C10	3n3 poly layer
C11	2n2 poly layer
C13	56p ceramic plate
C18,C19	1000µ 25V radial elect (2 off)
C21–C24	100n ceramic (4 off)

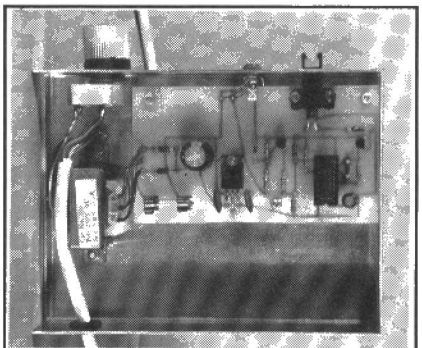
SEMICONDUCTORS

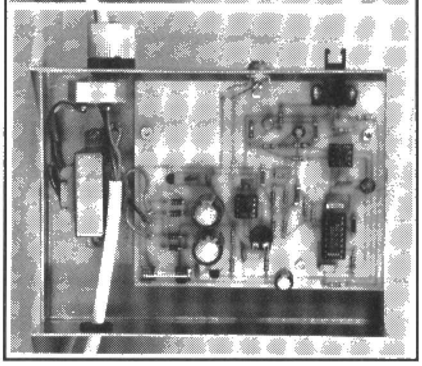
IC2	CA314OE
IC3	4046BE
IC4	LF351
IC6	LM317L
IC7	79L12
TR3	BPX25
TR4	BC109C
D5–D8	1N4002 (4 off)

MISCELLANEOUS

FS1 80mA, 20mm, antisurge; T1 mains primary, 12-0-12 volt 100mA secondary; SK2 3·5mm jack socket; S2 rotary mains switch; instrument case about 152 × 114 × 44mm; printed circuit board PE119; 20mm p.c.b. fuseclips (2 off); control knob; fibre optic socket; 16-pin d.i.l. i.c. holder; 8-pin d.i.l. i.c. holder (2 off); wire, solder, fixings, etc.







quite accurately without the aid of any test gear by setting up the system so that a test word is repeatedly sent from a computer or terminal feeding the transmitter, and displayed on a computer or terminal driven from the receiver. Obviously the way in which this is done will depend on the particular equipment you are using, but it should not be difficult to set up a loop program to automatically transmit a test word, and a simple program at the receiving equipment to print received characters on the screen. However, make sure that the receiving equipment can cope with the rate at which data is sent, and if necessary incorporate a timing loop in the transmission program to slow down the rate at which characters are sent to an acceptable level. A small range of settings should give uncorrupted data on the screen at the receiving end of the system, and VR1 is merely set at roughly the middle of this range. Make this adjustment with the system operating at the highest baud rate you will want to use, as it is at high baud rates that adjustment of VR1 is most critical.

About the Author

R. A. Penfold is probably Britain's best known designer of electronic constructional articles for the hobbyist. Over the years he has written dozens of electronics and computer books which have been well received around the world (he tells me he is not rich). Countless projects and feature articles, designed and written by Robert have appeared in *Practical Electronics* and innumerable other publications (shame on you!). Where does he get the time? Keep up the good work!

PEHB UNIVERSAL EPROM PROGRAMMER

BY LAURIE LAMBERT AND JERRY BROWSE

Blow almost any EPROM on the PEHB

This design combines some clever circuitry and excellent software to provide many useful features. Almost any EPROM can be catered for by employing specific personality matching modules. The project has been fully prototyped on the hobby bus but with a little imagination could be used in many other ways.

EPROM, or Eraseable Programmable Read Only Memories, are widely used in computer related electronic equipment to retain data when the equipment is powered down. There are other methods of retaining data of course, such as ROM's (Read Only Memories), battery backed CMOS RAM (Random Access Memory) or floppy disc drives. Each method has its advantages and disadvantages.

The main advantages of eproms is that the contents are easily changed, unlike a ROM; the speed of access to the data is instant compared to a disc drive and they require no back-up battery.

The main disadvantage of eproms is that you need a programmer to get the data in, and an eraser to clean the data out, when it is no longer required.

In this world of supposed standards it will come as no great surprise to the more cynical of us that there is no standard eprom pinout.

Most of the pins on commonly available eproms have the same function, but there are still several pins which have completely different functions on different eproms. Then there are different polarity signals required, differing combinations of Chip Select and/or Output Enable required, etc., etc. Table 1 shows pinouts for the more common eprom types.

A commercial Eprom Programmer can be a very expensive item, way beyond the pocket of all but the most affluent amateur. However, we have sought to design an eprom Programmer which will handle all the commonly available types from 2Kbyte upwards. The brief specifications are:–

***1.** Will program 2K types: 2516/2716 4K types: 2732/2532 8K types: 2764/2564 16K type: 27128 32K type: 27256. Single chip micro 63701 with adaptor.*

***2.** Can be easily adapted to program other types of eprom.*

***3.** Basic driver program, suitable for most home computers, offers facilities such as Read, Write, Copy, Dump to screen, Blank Check, Verify, etc.*

***4.** Reasonable cost.*

There are broadly two types of Eprom Programmer:–

***1.** The Stand-alone type, which may sometimes have a communication facility to accept a block of data from other equipment to program into the eprom, or may copy a master eprom. Most commercial versions of the stand-alone type have the ability to program several eproms at one go (with the same data of course!).*

***2.** The Peripheral type which operate under some degree of control of a host computer. The degree of control varies between totally dependent to semi-intelligent.*

The programmer presented here is of the peripheral type, being intended to operate on the PE Hobby Bus (PEHB).

CIRCUIT DESCRIPTION

Because the PEHB is intended for many different host computers, all with different system clock rates, the programmer could not use the host system clock to derive time-critical pulses, such as the program pulse (PGM).

This was overcome by using an on-board monostable, IC10, triggered by the host, with the output of the monostable available for test by the host as a Busy signal.

The programming of an eprom broadly consists of the following steps:–

***A.** Apply the programming voltage (Vpp) to the required eprom pin.*

***B.** Set up the eprom address lines with the data address and hold this address stable.*

***C.** Set up the eprom data lines with the data to be programmed and hold the data stable.*

***D.** Toggle the program pin on the eprom.*

These steps will be repeated for every data byte to be programmed. Normally the programming voltage will be set up at the start and only turned off at the end, though it may be left on during verify mode, in which the check for valid data programmed is made on a byte-by-byte basis rather than after a complete programming cycle.

The need to hold the address and data lines steady during the programming pulse period, typically 50mS, means that these values have to be latched onto the eprom lines.

Normally a Peripheral Interface Adapter offers the most cost effective solution to this latching requirement, but not in this case because of the programming overhead of PIA's and because of the large number of I/O lines required, some of which need to be bi-directional, which will also increase the programming overhead, particularly with the cheaper 6820 types.

Some programmers of this type use a binary counter, such as a CMOS 4040 to produce the address lines. This would then only require two lines to control, Clock and Reset. However there were two disadvantages to this approach:–

***A.** The 4040 has only twelve counter outputs, whereas we needed 14 for the largest eprom type. We could have cascaded two counters but this adds complications.*

***B.** It is difficult to set up a particular address using this method, because the counter has to be clocked through until the correct address is set up on the counter outputs, not difficult, but fussy.*

The approach we chose was to use 8 bit latches to capture data from the host computers data bus.

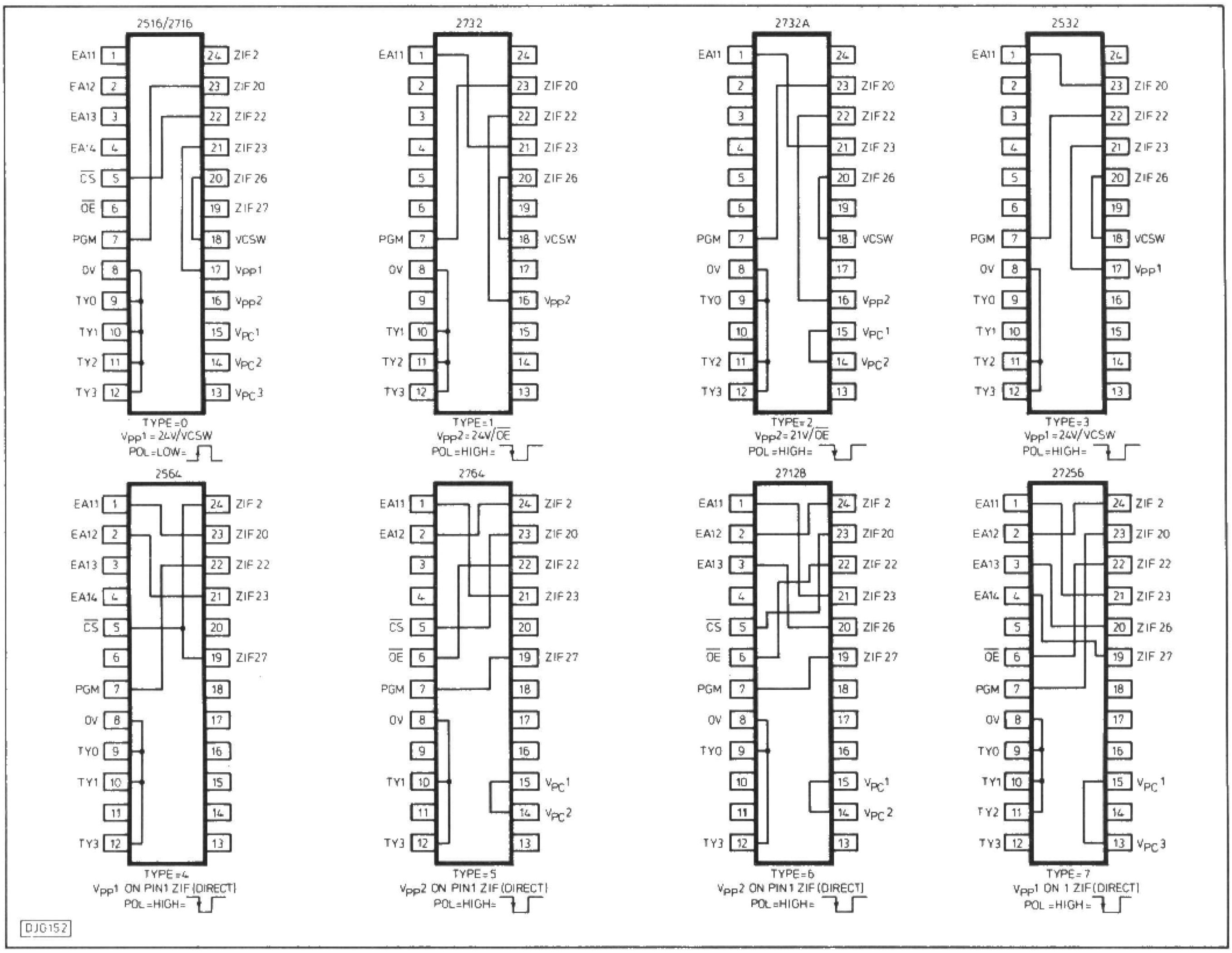
Four latches are required, one for the 8 eprom data lines, two for the (up to) 15 eprom lines and one for the control input lines.

Two 8 bit tri-state output buffers are used to present data to the host data bus, one for the eprom data in read mode and one for the control outputs.

Table 1.

Vpp	Vpp	Vpp					1	28					Vcsw	Vcsw	Vcsw
A12	CS1	A12					2	27					PGM	CS2	PGM
A7	A7	A7	A7	A7	A7	A7	3	26	Vcsw	Vcsw	Vcsw	Vcsw	NC	Vcsw	A13
A6	A6	A6	A6	A6	A6	A6	4	25	A8	A8	A8	A8	A8	A8	A8
A5	A5	A5	A5	A5	A5	A5	5	24	A9	A9	A9	A9	A9	A9	A9
A4	A4	A4	A4	A4	A4	A4	6	23	Vpp	Vpp	A11	Vpp	A11	A12	A11
A3	A3	A3	A3	A3	A3	A3	7	22	OE	CS	OE/Vpp	PD/PGM	OE	PD/PGM	OE
A2	A2	A2	A2	A2	A2	A2	8	21	A10	A10	A10	A10	A10	A10	A10
A1	A1	A1	A1	A1	A1	A1	9	20	CE/PGM	PD/PGM	CE/PGM	A11	CE	A11	CE
A0	A0	A0	A0	A0	A0	A0	10	19	D7	D7	D7	D7	D7	D7	D7
D0	D0	D0	D0	D0	D0	D0	11	18	D6	D6	D6	D6	D6	D6	D6
D1	D1	D1	D1	D1	D1	D1	12	17	D5	D5	D5	D5	D5	D5	D5
D2	D2	D2	D2	D2	D2	D2	13	16	D4	D4	D4	D4	D4	D4	D4
0V	0V	0V	0V	0V	0V	0V	14	17	D3	D3	D3	D3	D3	D3	D3

2716 Vpp = 25V
2516Vpp = 25V
2732Vpp = 25V
2732AVpp = 21V
2532Vpp = 25V
2764Vpp = 21V
2564Vpp = 25V



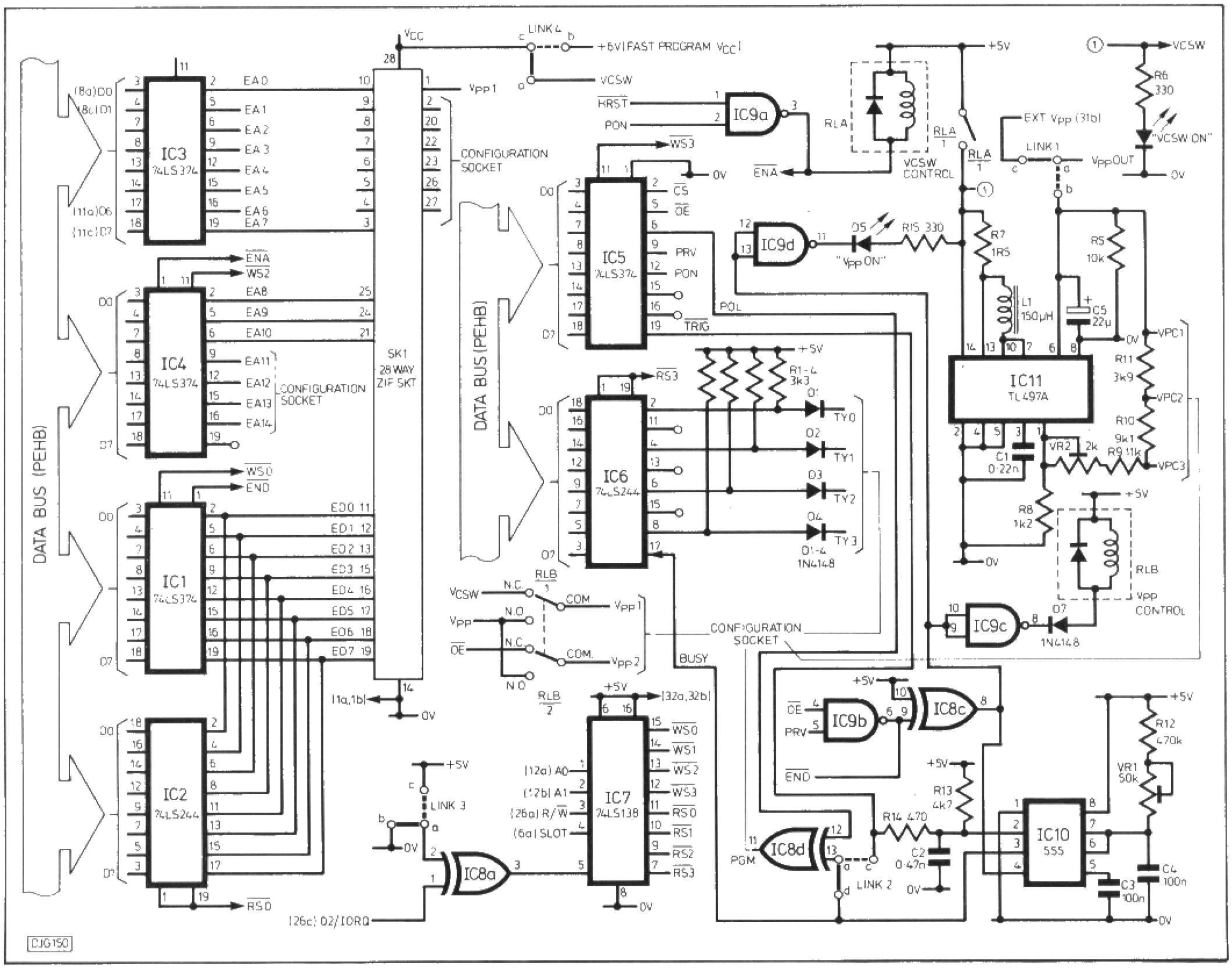


Fig. 1. *Complete circuit diamgram of the PE Universal Eprom Programmer*

The read and write strobes for these latches and buffers are derived from the 3 to 8 decoder, IC7.

The two low order address inputs for this decoder are supplied by the host's system address lines A0 and A1. The high order address input uses the R/W line.

One of the Slot Enable lines for the intended card position on the PEHB, each of which occupies a 4 address wide slot, is used as an enable line to IC7, which decodes the Slot signal into the 4 individual addresses. The system clock (Ø2) or IORQ is used as a further enable line via link 1 (LK1) and IC8a produces a negative true signal Ø2 barred. LK1 should be made a to c for 6502/6800 or a to b for Z80.

The result is 8 individual address strobes which only occupy 4 address locations, one read strobe (RS0-3) and one write strobe (WS0-3) for each address.

Only two of the four READ address strobes, RS0 and RS3, are used to enable the data and control buffers, IC2 and IC6. The remaining two read strobes, RS1 and RS2 are available for other purposes.

All four WRITE address strobes are used, one per input latch, WS0 (data), WS1 and WS2 (address), and WS3 (control).

The latches each have an output enable pin which is driven by the END line for the data latch and by the ENA line for the address and control latches.

ENA is a logical NAND of the reset line (RST and Power On (PON)) while END is a logical NAND of the Output Enable line (OE) and the programming supply voltage control line (PRV).

Thus data cannot be written to the eprom unless all other programming conditions have been met. Similarly, the eprom address line cannot be energised unless the eprom is powered up to 5V.

The programming pulse is generated by IC10, a 555 timer. This is triggered by a control line (TRIG) through the control port, producing a positive going pulse on its output, pin 3. This pulse is also available on the Control Port as a BUSY output, for use by the controlling program.

POLARITY CONTROL

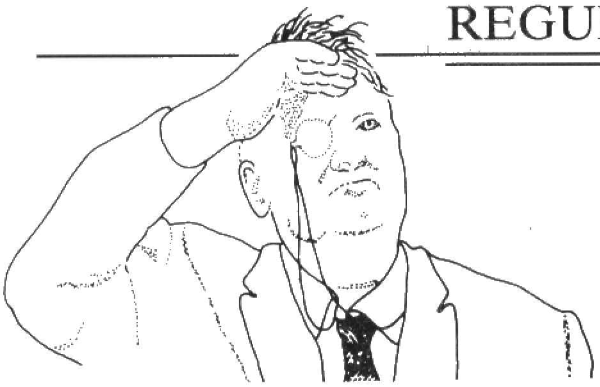
To cater for those eproms which require a different polarity PGM signal, the output of the timer, which is a 50mS wide pulse, is gated with the POLARITY control line (POL), through IC8d, an Exclusive OR gate so that the state of POL will determine the polarity of the PGM pulse. If POL is high then PGM will be active low, i.e. negative going, if POL is low the PGM will be active high.

The timer is held off via its reset pin through the data enable line, which guards against inadvertent operation of the PGM line.

VR1 allows setting of the PGM pulse width to the normal 50mS, or to any other setting if required for programming other eprom types.

For the more expert user LK2 allows by-passing of the timer. Control of PGM will then be via the TRIG line. However this requires a machine code driver program to be written. A suitable driver (in 6502 code) is available.

Continued next month



SPACEWATCH

BY DR PATRICK MOORE OBE

News of a new Aten-type asteroid, bringing the known total to six, plus interesting supernovas – tremendous stella explosions.

SADLY, the deaths of two well-known astromers have been reported recently. Dr Charles ('Chick') Capen died at his home in the United States; he was for many years on the staff of the Lowell Observatory, Flagstaff, and was best known for his observations of Mars. In Britain, Dr R.L. Waterfield has died. His main contribution was in studies of comets, and his photographs were outstanding – all the more because of his great physical handicap. During the war, while he was serving in the armed forces, he contracted polio, and was confined to a wheelchair – which did not prevent him from operating his observatory and his telescope without any assistance. Both these astronomers were old friends of mine; they will be badly missed. At the Lowell Observatory, Arthur Hoag has retired as Director, to be succeeded by Dr John S. Gallagher.

A new Aten-type asteroid has been discovered by Eugene and Carolyn Shoemaker at Palomar. Aten asteroids have orbital periods less than that of the Earth; only six are known – 2062 Aten, 2100 Ra-Shalom, 2340 Hathor, 3362 Khufu, 1954 XA (which has been lost), and now the newcomer, 1986 EB. All are very small, with diameters of only a few kiolmetres; whether they are the nuclei of dead comets is a matter for conjecture. From preliminary reports, the spectrum of the new object may indicate a metallic-type surface, which does not fit in well with current ideas about cometary nuclei.

Earlier this year it was reported that a new case had been found of a 'gravitational lens' – the splitting of light from a distant object into two distinct images. It was said that the body responsible could be a massive Black Hole, far larger and more massive than any previously known. The figures given sounded rather improbable – and so it has proved; there had been an error in observation, and the super-massive Black Hole does not exist. Of course, gravitational lenses do exist, but probably not upon so vast a scale as the original report suggested might be possible.

The fate of the Royal Greenwich Observatory is still undecided (at least at the time when I write these words). The Science and Engineering Research Council (SERC) has announced the intention of moving it to Cambridge, and closing Herstmonceux Castle. As this would interfere with overseas projects, wreck the library and archives, disrupt the educational programmes, cause the telescopes at Herstmonceux to be put out of use, and cost the taxpayer at least a million pounds, the suggestion seems – to put it mildly – remarkable. It has been opposed by leading astronomers everywhere, including Cambridge, and it is greatly to be hoped that the move will be avoided. Once the RGO has been dismantled, it could never be restored.

The Sky This Month

THE evening skies in September are reasonably well stocked with planets. Jupiter comes to opposition on the 10th, and is in the Pisces area; its magnitude is −2.4, so that it is much more brilliant than any star. Its opposition distance is 592,000,000 kilometres. Any small telescope will show the four Galilean satellites (Io, Europa, Ganymede and Callisto) which the Voyager spacecraft have shown to be such fascinating and varied objects. Saturn and Mars are also on view in the south-west after dark, though both are low down; Mars has faded in magnitude −1, so that it is much less prominent than Jupiter. Mercury is out of view, but Venus continues to be a magnificent object in the west after sunset – though unfortunately it is now moving southward, and by the end of the month it will have been lost in the evening twilight.

There are no eclipses this month, but you may consider making plans for the eclipse of the Sun on October 3. It is annular over most of its track, but there is a brief totality of less than one second over a small area in the North Atlantic. It will be very interesting to find out whether anyone actually manages to see the total phase. The Moon itself is new on 4 September and full on the 18th.

The 'Summer Triangle' (Vega in Lyra, Deneb in Cygnus and Altair in Aquila) continues to be conspicuous after dark, but Antares and the rest of Scorpius have been lost. The Square of Pegasus is high in the south; leading away from it is the line of stars marking Andromeda, and against a dark background the Great Spiral, Messier 31, should be visible with the naked eye. Adjoining Andromeda is Perseus, which contains the famous eclipsing binary Algol. Minima of Algol occur every 2½ days, when the magnitude drops to 3.4 instead of its customary 2.1; minimum lasts for only about twenty minutes. During September, minima at convenient times occur on the 5th (23.9 hours GMT), 8th (20.7h) and 26th (1.6h).

Below the Square of Pegasus, skirting the southern horizon, may be seen Fomalhaut in the Southern Fish – one of the bright stars found by the IRAS vehicle to have a large infra-red excess, possibly due to cool material surrounding the star which could indicate a planetary system (though it would be most unwise to jump to any conclusions). In the east, the lovely star-cluster of the Pleiades or Seven Sisters is coming into view. It cannot be mistaken, and its appearance in the evening sky is a sure sign that winter is on the way.

Supernovæ are tremendous stellar explosions, taking place upon a scale which it is difficult to picture. They are of two types. In the first, we have a binary system, one component of which is a Main Sequence star and the other a White Dwarf. The White Dwarf pulls material away from its companion, and this material grows in mass until it becomes unstable – and the White Dwarf is completely destroyed in a cataclysmic outburst. A Type II supernova involves a single star, more massive than the Sun, which collapses when all its nuclear 'fuel' is exhausted. There is an implosion, followed by a shock-wave which reaches the surface of the star and blows it away. The end product is a neutron star or pulsar; the gas-cloud gradually spreads out and dissipates.

Only four supernovæ have been seen in our Galaxy over the past thousand years. These were the stars of 1006 (in Lupus), 1054 (in Taurus), 1572 (in Cassiopeia) and 1604 (in Ophiuchus). Of these the Lupus supernovaa seems to have been much the brightest, though unfortunately it is not well documented; the 1054 star produced the Crab Nebula; the 1572 supernova is known as Tycho's Star, and that of 1604 as Kepler's Star. There was probably a supernova in 1702 or thereabouts which has produced the powerful radio source Cassiopeia A, but was not actually seen, because it was hidden by intervening material.

Astronomers would dearly like to study a galactic supernova with modern equipment; remember, even Kepler's Star was seen in pre-telescopic times. Nature has not been obliging, though in 1885 a supernova in the Andromeda Spiral reached the fringe of naked-eye visibility. However, there have been plenty of supernovæ seen in far-away galaxies, and several have been discovered by amateurs. The latest success stands to the credit of an Australian, the Rev. Robert Evans, who makes quite a habit of discovering supernovæ (not by accident; he makes regular, careful and skilled searches for them).

The new outburst is in the galaxy known as Centaurus A, or NGC 4151. This is a remarkable system, notably because it is crossed by a dark band. For many years it was believed to be a combination of two separate galaxies which were colliding, and passing through each other in the manner of orderly crowds of people moving in opposite directions; the individual stars would seldom collide, but the material spread between them would be in collision all the time, producing radio waves. Centaurus A is indeed a strong radio source. Unfortunately it is too far south in the sky to be seen from any part of Britain.

Subsequently it was found that this could not be the true answer. Centaurus A is a single galaxy, but a most unusual one. It is also exceptionally close; its distance has been given as about 13,000,000 light-years, which on the scale of the universe is not very far – though it is of course beyond the 'Local Group' which includes our Galaxy, the Magellanic Clouds, the Andromeda and Triangulum spirals, and a couple of dozen dwarf systems.

Evans' supernova apparently lies on the far side of the dark band in Centaurus A, so that its light is shining through. This is possible because all supernovæ are very powerful indeed. Type I supernovæ may attain well over 15,000,000 times the luminosity of the Sun, while those of Type II are only slightly less powerful. For the first time, then, we may be able to obtain direct information from the far side of the dark girdle of Centaurus A; we will learn more about the structure of the galaxy, and probably also obtain a more reliable estimate of its distance.

Certainly the event is an important one, and has been followed by all major observatories from which Centaurus A can be seen. It illustrates, too, how great can be the contributions made by amateur astronomers. Here in Britain, there are several amateurs who have begun systematic hunts for supernovæ in outer galaxies; no doubt Evans' latest success will spur them on to even greater efforts in the future. PE

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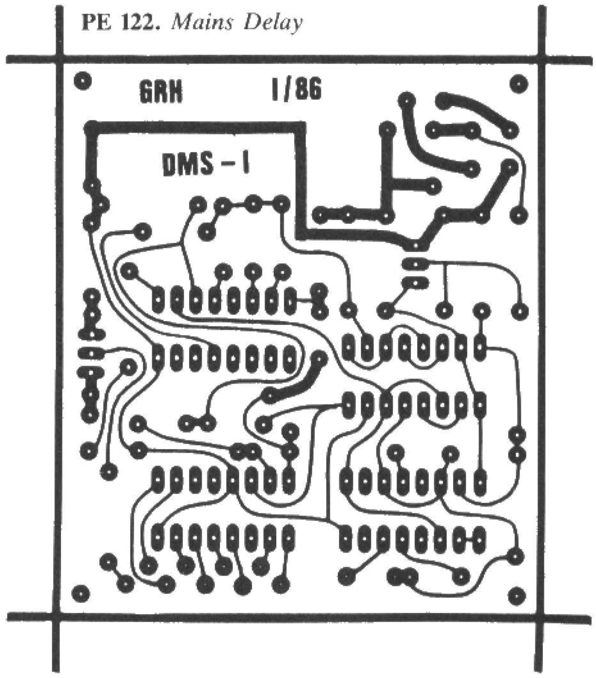
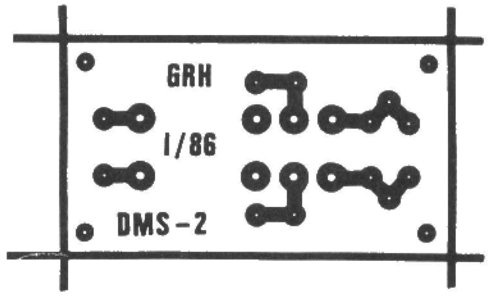
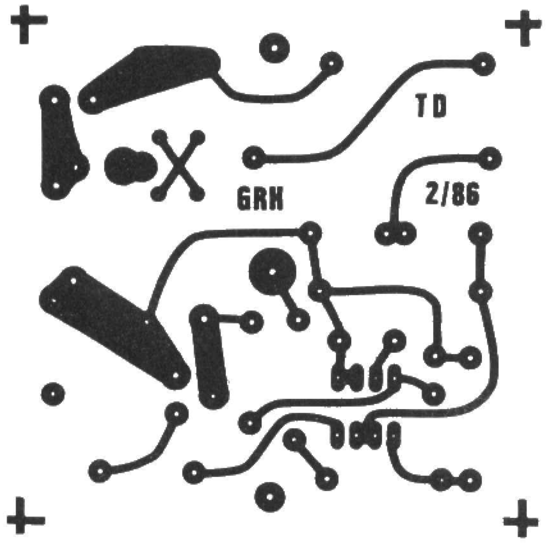
PE 122. *Mains Delay*

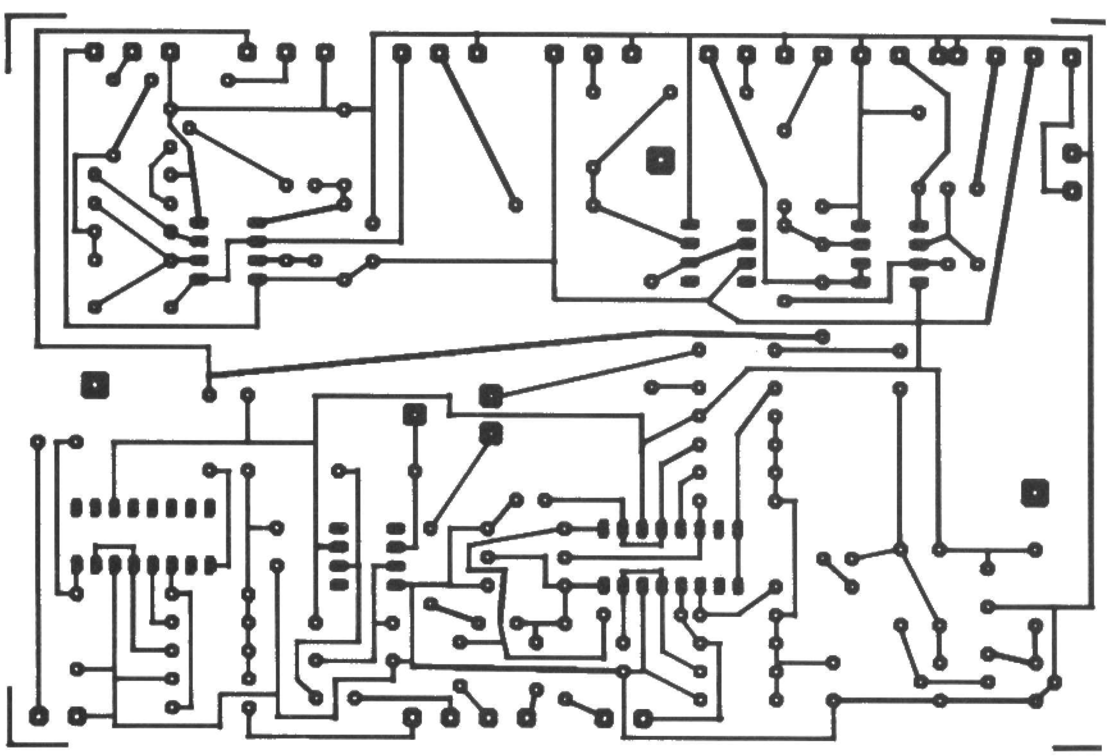






PE 123. *Mains Dimmer*

PE 121. *Drum Synthesizer*



ROBOTS IN THE FUTURE

BY BERRY-ANNE BILLINGSLEY

The shape of things to come

Perhaps, when it comes to robots, we are expecting the wrong thing. What is a robot? The PE Robotics Preview has the answer?

THE robot butler walked up to the flashing intercom light.

"Yes sir?" it asked brightly. The voice from the bedroom replied,

"Coming right up, sir."

Robuttle returned stiffly to the sink and ran the hot tap. It tested the water with a temperature-sensitive middle finger and then nodded its cybernetic head. Humming cheerfully, the robot filled the saucepan exactly half full.

Laser lights sprouted from its eyes and it scanned the contents of the fridge until its polyplastic hand gripped the egg box. "Only two eggs left. Must put out a note", it muttered and dropped them carefully into the pan.

"And while they cook, I've just time to make the toast", it smiled.

Is that your picture of the breakfast machine of tomorrow? Don't throw your alarm clock away just yet. Robotics still has a very long way to go. Just consider the complicated decisions involved in taking an egg from the box – assuming the robot grabbed the egg box out of the fridge and not a slab of cheese.

First, the box must be held facing the right way. Next our android must battle with the closing tabs, which often prove too much for the able fingered human. Then it must check each cup for an egg, and if its aim is slightly off you could be looking forward to scrambled egg box on toast.

Holding an egg is a tricky business unless you own a million yen gripper. And by the time his binary brain has worked out the correct approach to the bottom of the saucepan, breakfast will have hatched.

A couple of car advertisements have capitalised on the robot dexterity of some very flashy welding machines. They look extremely advanced, but just how intelligent are they? It is relatively easy to programme a robot arm to perform an elaborate sequence of graceful pirouettes – as long as it need only do the same thing every time.

The sequence is built up of individually programmed moves – for example:

A = "up three units, left one unit, welder on"
B = "down four units, right three units, up eight units, welder off"
C = "Goto base"
D = "C + A + B – 2A + C"

Give the robot a practice at a low speed to check for any errors and then let it rip – which is exactly what it will do if the car is not precisely on its mark. These automated welders could be described as an up-to-date version of the old musical-box clock-work dolls.

But at least in the car factory, the robot is trying to make a contribution. We haven't seen a cybernetic hair of his micro-processor head when it comes to the household drudgery. In fact the nearest relative to an android in the kitchen is the washing machine!

Don't discriminate against washing machines just because they are squat and dumpy! They are at least as intelligent as a welding robot. You inform your machine that you have filled its stomach with your best woollies and it works out the temperature.

And if you tell it lies, can you really blame the trusting metal soul for pulverising your cardigan?

But you are right – the washing machine does not fit the description of a robot. Now a cybernetic coat stand who tilts, "Have a nice day", as it takes your umbrella (and carefully puts it on a hanger) – that's a robot.

Perhaps we are expecting the wrong shape of machine from our technological boffins. And perhaps that is why we have seen so little progress. If all we want is a boiled egg in bed, then technology could already provide the service. But it won't look like a butler.

How does this new scenario grab you? The man touched button A on his bedside control and in the kitchen, "Easyboil" switched on its receptor.

"Egg", said the man and then louder, "EGG!"

The boiler, a box the size of a cereal packet, filled one of its tins with water from the mains. The element soon pepped it up to boiling and the thermostat then regulated the water to a steady bubble. One egg plopped out of the cooled tube into the tin. Exactly two and a half minutes later, the container drained and the egg dropped neatly into a disposable egg cup.

There was a subtle hum as the service lift wafted up to the bedroom and a thud as it jerked to a stop.

Fred, sitting comfortably in bed with his teaspoon at the ready, whisked his egg from the lift. "This is the life", he grinned contentedly.

It isn't such a romantic picture as the chummy android, but it would cost very much less, besides being possible now. Do today's engineers need a prod in the right direction?

But I must admit, "Robuttle" certainly has the edge when Fred realises he has run out of salt! PE